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**PHYSICAL FITNESS TESTING BY THE  
U.S. AIR FORCE ACADEMY, 1955-1981**

James C. Miller, Ph.D.

Robert D. Shadduck, Captain, USAFR (U.S. Air Force Academy)

Kory G. Cornum, Second Lieutenant, USAF

September 1983

Final Report for Period August 1981 - August 1982

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USAF SCHOOL OF AEROSPACE MEDICINE  
Aerospace Medical Division (AFSC)  
Brooks Air Force Base, Texas 78235

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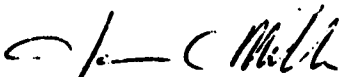
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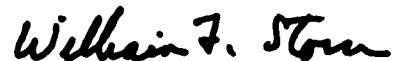
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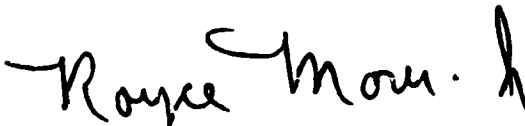
This report has been reviewed and is approved for publication.



JAMES C. MILLER, Ph.D.  
Project Scientist



WILLIAM F. STORM, Ph.D.  
Supervisor



ROYCE MOSER, Jr.  
Colonel, USAF, MC  
Commander

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER USAFSAM-TR-83-22	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle)  PHYSICAL FITNESS TESTING BY THE U.S. AIR FORCE ACADEMY, 1955-1981		5. TYPE OF REPORT & PERIOD COVERED Final Report Aug 1981 - Aug 1982
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) James C. Miller, Ph.D.; Robert D. Shadduck, Captain, USAFR (Admissions Liaison Office, U.S. Air Force Academy); Kory G. Cornum, Second Lieutenant, USAF		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS USAF School of Aerospace Medicine (VNE) Aerospace Medical Division (AFSC) Brooks Air Force Base, Texas 78235		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS  62202F 7930-10-28
11. CONTROLLING OFFICE NAME AND ADDRESS USAF School of Aerospace Medicine (VNE) Aerospace Medical Division (AFSC) Brooks Air Force Base, Texas 78235		12. REPORT DATE September 1983
		13. NUMBER OF PAGES 92
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report)  UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report)  Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)  Physical Fitness      Candidates      Testing Strength      Cadets      Energy Expenditure Aerobics      Physical Aptitude      Weight Altitude      Endurance      Practice		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report documents the histories of the Physical Fitness Test (PFT) and the Aerobics Run, as applied to USAF Academy Cadets, and the Physical Aptitude Exam (PAE) taken by Academy applicants, and briefly discusses the nature of Basic Cadet Training. Data concerning applicant practice of PAE events are presented. A reference bibliography of USAFA reports about the PFT and PAE is included. The report of a working group, which recommended changes to USAFA physical fitness testing procedures, is appended.		

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## PHYSICAL FITNESS TESTING BY THE U.S. AIR FORCE ACADEMY, 1955-1981

### INTRODUCTION

The U.S. Air Force Academy (USAFA) has screened candidates with regard to physical strength and aptitude since 1955. The USAFA has also tested the strength and endurance of cadets, twice per year, since 1961. The cadets have been required to perform the Air Force Aerobics run since 1970. In the process of administering these three tests and regularly reexamining their validity, members of the USAFA staff have generated a number of technical papers. Unfortunately, these papers have not been published nor widely circulated. This report compiles and summarizes the available information about USAFA's approach to physical fitness (and physical aptitude) testing.

The report is divided into sections that deal with (a) the Physical Fitness Test given to Fourth through Second Class (freshmen through junior) cadets, (b) the Aerobics run performed by all cadets, (c) the Physical Aptitude Examination given to candidates, and (d) the physical demands of Basic Cadet Training. A reference bibliography is included. The latter was compiled from the reference sections of papers discussed in this report.

### PHYSICAL FITNESS TEST (PFT)

The following summary of the Physical Fitness Test, provided by the USAFA Directorate of Athletics (AH), adequately explains the history and requirements of the test:

#### History of AFA Physical Fitness Test

In October 1961, the Director of Athletics became convinced that the First Classmen were not securing enough physical exercise to maintain their physical fitness. Although these cadets participated in the intramural sports program, the majority were coaches, officials, or administrators and in effect, were non-participants. In order to assure the graduating cadet would enter service life with a relatively high level of physical fitness, Colonel Martin proposed the following to the Academy Board:

- a. Require First Classmen to take a physical fitness test semiannually during the months of October and April.
- b. Require each cadet who fails to achieve a total score of 250 in October to take a weekly re-test until a minimum total score of 250 is achieved.
- c. Require each cadet who fails to achieve a total score of 250 and fails to meet minimum standards for each test item in April to be re-tested each week until minimum standards are met.

- d. On or about 1 June, cadets who are still deficient will be reported to the Superintendent and the Academy Board as being deficient in physical fitness. (Memo, Dir of Ath, Subj: Physical Fitness Test for the First Class)

Each First Classmen would be required to meet the following minimum standard of performance.

Pull-ups	7
Standing Broad Jump	7 feet
Push-ups	30
Sit-ups (2 minutes)	50
600 yard run	1:50.0

The Academy Board thoroughly discussed the recommendations of Colonel Martin and a proposed cadet regulation governing physical fitness. Minor changes were made in the regulation. The Board then unanimously approved the recommendations and the new regulation. (Minutes, Academy Board Meeting, 16 Oct 61)

No historical records are available to indicate the origin of the five item test although it can be safely assumed that the test was derived from similar tests being administered both in civilian universities and at USMA during this time period.

By 1968 the PFT had undergone minor changes in its minimum requirements. These changes based on over 5000 cadet scores are shown below:

	<u>Pull- ups</u>	<u>SBJ</u>	<u>Push- ups</u>	<u>Sit- ups</u>	<u>600 Yd Run</u>
4th Class (Freshmen) 1st Sem			NONE	ESTABLISHED	
4th Class (Freshmen) 2nd Sem	3	6'06"	24	40	2:07
3rd Class (Sophomores) 1st Sem	5	6'09"	27	45	2:04
All Others (Juniors & Seniors)	7	7'00"	30	50	2:00

For 1981 these minimums are:

(MEN)

4th Class (Freshmen) 1st Sem					
4th Class (Freshmen) 2nd Sem	4	6'08"	26	45	2:10
3rd Class (Sophomores) 1st Sem	6	6'11"	29	50	2:06
All Others (Juniors & Seniors)	8	7'02"	32	55	2:03

(WOMEN)

4th Class (Freshmen)	1st Sem					
4th Class (Freshmen)	2nd Sem	1	5'02"	7	42	2:26
3rd Class (Sophomores)	1st Sem	2	5'05"	9	46	2:23
All Others (Juniors & Seniors)		3	5'08"	11	50	2:20

In order to weigh the five test items equally, a standard 0 to 100 point scale was established for each item, so that the highest possible combined score was 500.

The 0 to 100 point scale chosen was the T-scale, which can be computed for any set of scores, regardless of the unit of measurement. (feet and inches, minutes and seconds, etc.)

The T-scale was chosen instead of the percentile method because all the units on a T-scale are at intervals of equal distance throughout the scale. On a percentile scale, the scores may be closely grouped near the mean and spread out at each end of the scale. This means that T-scores can be averaged together more accurately than percentile scores.

The women's and men's distributions of raw scores, with associated T-scores, are presented in Tables 1 and 2, respectively.<sup>1</sup>

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<sup>1</sup>On the T-scale, the mean is 50, and each standard deviation above or below the mean is an increment of 10. Thus, two standard deviations below the mean is a T-score of 30, two above is 70. See Appendix A.



TABLE 1. WOMEN'S PFT CONVERSION CHART, JULY 1979

PULL-UPS		LONG JUMP		PUSH-UPS		SIT-UPS		600-YD RUN	
Raw	Std	Raw	Std	Raw	Std	Raw	Std	Raw	Std
Score	Score	Score	Score	Score	Score	Score	Score	Score	Score
						85	100	113	100
						84	98	114	98
						83	96	115	96
						82	94	116	94
						81	92	117	92
						80	90	118	90
						79	88	119	88
						78	86	120	86
						77	84	121	84
						76	82	122	82
						75	80	123	80
						74	78	124	78
						73	76	125	76
						72	74	126	74
						71	72	127	72
						70	70	128	70
						69	68	129	68
						68	66	130	66
						67	64	131	64
						66	62	132	62
						65	60	133	60
						64	58	134	58
						63	56	135	56
						62	54	136	54
						61	52	137	52
						60	48	138	50
						59	46	139	46
						58	44	140	42
						57	42	141	38
						56	40	142	34
						55	38	143	30
						54	36	144	26
						53	34	145	22
						52	32	146	18
						51	30	147	14
						50	28	148	10
						49	26	149	6
						48	24	150	2
						47	22	151	0
						46	20		
						45	18		
						44	16		
						43	14		
						42	12		
						41	10		
						40	8		
						39	6		
						38	4		
						37	2		
						36	0		
						35			
10	100								
9	90								
8	80								
7	70								
6	60								
MEAN									
5	50								
4	40								
***3	30								
**2	20								
*1	10								
0	0								

\*Denotes 4<sup>th</sup> - 1st Semester\*\*Denotes 3<sup>rd</sup> - 1st Semester\*\*\*Denotes 3<sup>rd</sup> - 2nd Semester

TABLE 2. MEN'S PFT CONVERSION CHART, JULY 1979

PULL-UPS		LONG JUMP		PUSH-UPS		SIT-UPS		600-YD RUN	
Raw	Std	Raw	Std	Raw	Std	Raw	Std	Raw	Std
Score	Score	Score	Score	Score	Score	Score	Score	Score	Score
				65	100				
				64	98				
				63	96				
				62	94				
				61	92				
				60	90			95	100
				59	88			96	97
				58	86			97	94
				57	84			98	91
				56	82	85	100	99	89
				55	80	84	97	100	86
		9'0"	100	54	78	83	94	101	83
		8'11"	97	53	76	82	91	102	80
		8'10"	93	52	74	81	88	103	78
		8'9"	90	51	72	80	85	104	76
		8'8"	87	50	70	79	82	105	74
		8'7"	83	49	68	78	79	106	72
		8'6"	80	48	66	77	76	107	70
20	100	8'5"	77	47	64	76	73	108	68
19	94	8'4"	73	46	62	75	70	109	66
18	89	8'3"	70	45	60	74	67	110	64
17	83	8'2"	67	44	58	73	64	111	62
16	77	8'1"	64	43	56	72	61	112	60
15	72	8'0"	60	42	55	71	58	113	58
14	66	7'11"	57	41	54	70	56	114	56
13	61	7'10"	54	40	52	69	54	115	54
12	55	7'9"	52	39	51	68	52	116	52
MEAN		7'8"	50	38	50	67	50	117	50
		7'7"	47	37	48	66	48	118	48
		7'6"	45	36	45	65	46	119	45
***	8	7'5"	43	35	42	64	44	120	43
	7	7'4"	40	34	39	63	42	121	40
**	6	7'3"	37	33	36	62	40	122	38
	5	***7'2"	35	***32	33	61	38	***123	35
*	4	7'1"	32	31	30	60	36	124	33
	3	7'0"	30	30	27	59	34	125	29
	2	**6'11"	27	**29	24	58	32	**126	25
	1	6'10"	25	28	21	57	30	127	21
		6'9"	23	27	18	56	28	128	18
		*6'8"	20	*26	15	***55	26	129	15
		6'7"	17	25	12	54	24	*130	11
		6'6"	15	24	9	53	22	131	8
		6'5"	12	23	6	52	20	132	6
		6'4"	10	22	3	51	18	133	4
		6'3"	7	21	1	**50	16	134	2
		6'2"	5	20	0	49	14	135	0
		6'1"	2			48	12		
		6'0"	0			47	10		
						46	8		
						*45	6		
						44	5		
						43	4		
						42	3		
						41	2		
						40	1		

\*Denotes 4<sup>th</sup> - 1st Semester  
 \*\*Denotes 3<sup>rd</sup> - 1st Semester  
 \*\*\*Denotes 3<sup>rd</sup> - 2nd Semester

As noted by AH, the criteria for passing the PFT exercises are based on the distributions of 5000 cadet scores compiled over two years. Based on this sample of cadets, the standard scores predict the following numbers of failures per 1000 male cadets in each exercise in each class:

	<u>pull-ups</u>	<u>long jump</u>	<u>push-ups</u>	<u>sit-ups</u>	<u>600-yd run</u>
4th class, 2nd sem	0	1	0	0	0
3rd class, 1st sem	6	11	5	0	6
All others	67	67	45	8	67

Failures per 100 female cadets in each exercise in each class would be:

4th class, 2nd sem	0	0	0	0	0
3rd class, 1st sem	0	1	1	0	2
All others	2	7	4	1	21

As one can see, the tests receive varied emphases, and the tests all become more discriminating with Cadet progress at USAFA. Originally, the end-of-3rd-class-year criterion for each exercise was two standard deviations below the mean, or a T-score of 30, which predicts a 2.3% failure rate (Lt Col Thomas, personal communication). The rationale for the current set of criteria may not be well documented. There are also some problems with the sampling that produced the distributions for men and women. The men's sample of 5000 contains an unknown number of test repetitions by cadets, and an unknown distribution of time of testing (i.e., 4th class, 3rd class, etc.). The women's sample may only contain about 300 women (the first two classes) unless it has been updated since Lt Col Thomas departed AH. Recently (fall 1981), AH considered using the third class, second semester criteria (\*\* in Tables 1 and 2) as criteria for all cadets.

The brief summary of the PFT provided by Walter (1970) in the introduction to his dissertation contains a description of the genesis of the rapid testing procedure adopted by AH. This procedure allows a regulated 3 minutes per exercise, in the order: pull-ups, long-jump, push-ups (number in 2 minutes), sit-ups, and the start of the 600-yd run.

Cadets were tested on an individual basis in the past but recently have been tested on a mass basis called the station system. This was done to accommodate the growing number of cadets. The station system requires twenty-eight to thirty-five hours of testing and retesting per semester with a current enrollment of over 3800 cadets. Local studies made of the PFT show that: it relates well to the PAE, performance drops off in the senior year, and continued motivation is necessary to maintain a high level of performance.

#### PFT Historical Records

The following excerpts from USAFA historical records, available from the USAFA library, document a number of years of progress in administering the PFT. The integration of the Aerobics run (1971-72) and weight monitoring (1977) programs with the PFT is also documented here.

1964-65 (academic year):

During the summer program, the physical fitness test was administered twice, the week of 13-17 July and the week of 11-14 August. The station method of administering the test was used for the first time and was "far superior" to previous methods employed. After starting the first test item, the Basic Cadet completed the physical fitness test in 15 minutes. Five of the cadets completed each item in three minutes or less. "This provided the capability of running 100 to 120 basic cadets through the PFT in approximately 40 minutes." Members of the First Class Detail served as test administrators for each testing cycle. The detail members required only one 15-minute orientation briefing to prepare them for the testing. (Rpt, OIC, PFT, to DAPE, Subj: After Action Report, Physical Fitness Testing, 13 Aug 64)

The first physical fitness test was completed by 811 Basic Cadets; 128 were medically excused. The mean for each was as follows: (Ibid)

	<u>Class of 1968</u>	<u>Class of 1967</u>
Pull-ups	7.73	8.15
Standing Broad Jump	7'3.2	7'3
Dips	13.95	17.57
Sit-ups	62.4	66.01
600-Yard Run	1 min 50.9 sec	1 min 43.6 sec
Total Converted Score Mean	248	280

The Department of Physical Education believed there were two reasons why the Class of 1968 had a lower mean score than the Class of 1967. In the first place, the test was administered with very little rest between the test items - 15 minutes, as compared to the 50 minutes allowed the previous summer. This would have a definite effect on the performance of the last three test items. Secondly, the Basic Cadet in the previous summer had been permitted to rest in the straight arm position while performing the dips on the parallel bars, a practice which was forbidden in the summer of 1963. This might account for the fact that the mean was lower for the Class of 1968. However, the Class of 1968 as a whole exhibited a weaker upper body area. Their pull-ups were less and their sit-ups were considerably lower than those of the Class of 1967. Furthermore, the 600 yard run by the Class of 1968 was considerably slower. This might partially be explained "by the lack of rest after performing the sit-ups, and the lack of pacing knowledge exhibited by each basic cadet." (Ibid)

1966-67 (academic year):

A complete analysis of the PFT Program made during the reporting period indicated that the mean PFT score of the Wing rose from 249 in the fall to 254 in the spring, which was four points between the top and bottom squadrons. Although the PFT was an individual item, it was felt that internal squadron motivation played a big part in each cadet's score. Several squadrons, it was noted, engaged in intrasquadron competition and/or extra conditioning programs for their weak cadets, obviously with considerable success. Also noted was a steady decline in the performance of the First Classmen dating from the spring testing period in their Second Class year. (Report, DAEX to DOIH, Subject: Superintendent's Semi-annual Report, 26 July 1967)

1967-68 (academic year):

During the fall semester Research and Evaluation Division administered the Physical Fitness Test (PFT) with significant results. Each of the classes showed an increase in its mean score over that of the previous spring. The First Class reversed a trend toward poorer performance in the First Class year. However, in the spring, the First Classmen again showed a decline but their fall mean score was the highest in their four years at the Academy. In the fall semester, 37 cadets scored over 400 points on the PFT and one member of the Class of 1968 achieved a perfect score of 500. In the spring, the Division completed a thorough analysis of the PFT program for the 1967-68 academic year. "The mean PFT score of the entire Wing was raised from 255 in the fall to 278 in the spring. This was 28 points above the statistically predicted mean of 250. An order of mean list was compiled for all of the squadrons based on each squadron's mean score. There was a difference of over 56 points between the top and bottom squadrons." (Reports, DAEX to DOIH, Subject: Superintendent's Semiannual Reports, 31 January 1968 and 24 July 1968)

1970-71 (academic year):

Volume 5 of the Academy Physical Education Research Digest was published; it contained abstracts of the following eight completed research studies: (1) Research Abstracts; (2) Physical Aptitude Examination (PAE) Synthesis; (3) PAE Comparison of Selected Data; (4) PAE Comparison of Athletes by Sport; (5) Physical Fitness Test (PFT) Comparison of Athletes by Sport; (6) Athlete/Non-Athlete Comparison of Academic Grades, PE Grades, PAE and PFT; (7) Athlete/Non-Athlete Comparison of Attrition; and (8) Comparison of Swim Test Results. (Input...AHX, 18 June 1971)

1971-72 (academic year):

A total of 6,618 cadets took the physical fitness test (PFT) during this academic year. The Cadet Wing mean was 260. For the second successive year the Air Force Aerobics Test was used in lieu of the PFT for First Classmen, who "definitely prefer" the Aerobics Test. (Rprt, AHX to HQ, 12 Jul 72 (Atch 3))

Scores on the PFT administered to the Class of 1975 on 8-9 July follow, as does a comparison of PFT scores over the last 4 years. (Memo for Record, Capt K. R. Ziegler, OIC, Physical Assessments, subj: After Action Rprt, First PFT (Summer 1971), 12 Aug 71)

<u>Class</u>	<u>Average Mean Score</u>
1975	219.57
1974	250.52
1973	238.47
1972	216.93 [Aerobics run]

Comparison of Five Test Items by Class

<u>Test Item</u>	<u>1975</u>	<u>1974</u>	<u>1973</u>	<u>1972</u>
Pull-Ups	9.17	10.65	9.52	8.6
Broad Jump	7'10.28"	7'7.46"	7'5"	7'4.47"
Push-Ups	22.86	35.41	34.6	33.2
Sit-Ups	63.27	67.30	65.4	62.3
600-Yd Run	2:02.29	1:52.41	1:50.2	1:52.20

Additional Results (Class of 1975)

High Score	454
Low Score	36
Zero Pull-Ups	9
Medical Excusals	40
NOR, INC*	25
400 Club	5

\*No official reason or incomplete - includes all cadets who did not sign into the Academy, or who processed out during the first week.

1972-73 (academic year):

Minimum scores for the PFT were:

<u>Class</u>	<u>Semester</u>	<u>Pull-Ups</u>	<u>Standing Broad Jump</u>	<u>Push-Ups</u>	<u>Sit-Ups</u>	<u>600- Yd Run</u>
4th	1st		None Established			
4th	2nd	3	6'06"	24	40	2:07
3rd	1st	5	6'09"	27	45	2:04
All other cadets		7	7'00"	30	50	2:00

This year's Wing mean standard for the PFT was 263.8 points, compared to a mean score of 260.0 points the preceding year. (Report, AH to HO, 2 July 1973)

1974-75 (academic year):

The same minima were required as in 1972-73.

Also, the wing mean standard score for the PFT was 265.3 points, slightly higher than the 264.8 mean from the previous year. This can be broken down by class as follows:

<u>Class</u>	<u>Mean Standard Score</u>
*1975	272.8 [Aerobics run]
1976	272.8
1977	263.5
1978	258.1
Wing	265.3

\*First classmen ran the 1 1/2 mile run in lieu of the PFT; however, their scores were converted to the same standard scale.

The May Elective Program was no longer in existence, per se. First Classmen took an Aerobics Program in which they construct their own workout schedule in order to participate in enough aerobic activities to gain "20 aerobics points" per week. A great variety of activities were available to them and they participated during their free time, keeping their own records. They had only one "scheduled" physical education class during which they were briefed on the Aerobics Program. The intent was to groom a fitness program of enjoyable activities for later use as officers in the Air Force. This course proved to be enjoyable and rewarding to the First Classmen and far more beneficial than the previous May Elective Program.

1975 (Jul-Dec):

The same minima were required as 1972-1973.

The Cadet Wing mean standard score for the fall semester was 262.5. Broken down by class the mean standard scores reflected the following:

Class	Mean Standard Score
1976	299.3 [Aerobics run]
1977	263.8
1978	249.6
1979	237.4

1976 (calendar year):

The minima were:

CLASS	SEMESTER	*FLEX-ARM HANG PULL-UPS	LONG JUMP	PUSH-UPS	SIT-UPS	600-YD RUN
		NONE ESTABLISHED				
Fourth	First					
#Fourth	Second	15 sec	5'0"	5	38	2:25
+Fourth	Second	3	6'6"	24	40	2:07
Third	First	5	6'9"	27	45	2:04
Third	Second	7	7'0"	30	50	2:00
Second	First	--	--	--	--	--
Second	Second	7	7'0"	30	50	2:00

\*Indicates flex-arm hang for women in seconds instead of pull-ups.

#Women

+Men

[Note the inclusion of the flexed-arm hang in the PFT.]

First Classmen and Second Classmen (first semester only) take the standard Air Force Aerobics 1.5 mile distance run in lieu of the physical fitness test (PFT). Maximum allowable time for this run is 11:45 minutes. Run times are converted to a standard scale. The Cadet Wing mean standard score for the Fall Semester 1976 PFT was 279.19 points, broken down by class as follows:

Class	Mean Standard Score
1977	288.25 [Aerobics run]
1978	318.59 [Aerobics run]
1979	260.19
1980	249.68

AHPE monitored the reconditioning program. During BCT [Basic Cadet Training] 322 cadets attended reconditioning; 218 men and 104 women. In the Fall Semester 1976, there were 15 PFT failures enrolled in



reconditioning. In addition, there were 36 cadets in the Class of 1980 who were identified as marginal performers (when compared to Fourth Class second semester minimums) but were not enrolled in reconditioning. This was the first time Fourth Classmen were not placed in reconditioning after performing below standard. Fourteen upperclassmen served as reconditioning supervisors and counselors.

1977 (calendar year):

Once each semester every cadet is required to take the PFT. Second Class, first semester, and all First Classmen took the 1 1/2 mile aerobics run in lieu of the PFT. The maximum for the women's 1 1/2 mile run has not been established. The following table shows the minimum passing scores for the other classes on the PFT:

<u>Class</u>	<u>Semester</u>	<u>Sex</u>	<u>Pull-Ups</u> <u>Fl Arm Hang</u>	<u>Standing</u> <u>Broad Jump</u>	<u>Push-Ups</u>	<u>Sit-Ups</u>	<u>600-Yd Run</u>
4th	1st	M		None Established			
4th		W					
4th	2nd	M	3	6'6"	24	40	2:07
		W	15 Sec	5'0"	5	38	2:25
3rd	1st	M	5	6'9"	27	45	2:04
		W	18 Sec	5'3"	7	42	2:20
3rd	2nd	M	7	7'0"	30	50	2:00
2nd	2nd	W	22 Sec	5'6"	9	45	2:15

[Note the inclusion of the flexed-arm hang for women again.]

The Wing mean standard score for the Fall 1977 semester PFT was 295.55 points, higher than the 276.27 mean from the Spring 1977 PFT. This can be broken down by class as follows:

#### Mean Standard Scores

<u>Class</u>	<u>Spring '77</u>	<u>Fall '77</u>
1981	--	275.67
1980	270.35	260.80
1979	291.58	330.67
1978	292.39	315.08 [Aerobics run]
1977	250.63	-- [Aerobics run]

First and Second Classmen took the 1 1/2 mile run in lieu of the PFT; however, their scores were converted to the same standard scale.

A reconditioning program was conducted each semester. Trainees were PFT and aerobics run failures. Women were enrolled during the spring cycle for the first time.

In addition, a weight monitoring and control program was initiated this year. Cadet weights were monitored through a computer program. Overweight cadets were identified, counselled, given physical activity programs and diet assistance.

1978 (calendar year):

All cadets were required to take the PFT and Aerobics Test each semester except the First Class. The First Class was required to run the Aerobics Test each semester. Aerobics testing was conducted by individual squadrons with the Evaluation Branch supplying the computer cards, computing the results, and supervising the remedial training, if required. Only those cadets in the category of on-season intercollegiate athletics or cadets having currently 400/500 PFT Club status, or cadets having a valid medical excusal with a blue slip were excused from taking the PFT. With the exception of 500 Club members, excused cadets must take the PFT and Aerobics Test at least once during each academic year.

The new PFT minimum standards are as follows:

<u>Fourth Class</u>		<u>Men</u>	<u>Women</u>
(1)	Pull-ups	3	1
(2)	Standing Long Jump	6'6"	5'0"
(3)	Push-ups	24	5
(4)	Sit-ups (2 min)	40	38
(5)	600-yard run	2:07 min	2:25 min
<u>Third Class, First Semester</u>		<u>Men</u>	<u>Women</u>
(1)	Pull-ups	5	2
(2)	Standing Long Jump	6'9"	5'3"
(3)	Push-ups	27	7
(4)	Sit-ups (2 min)	45	42
(5)	600-yard run	2:04 min	2:20 min
<u>Third Class, Second Semester and Second Class</u>		<u>Men</u>	<u>Women</u>
(1)	Pull-ups	7	3
(2)	Standing Long Jump	7'	5'6"
(3)	Push-ups	30	9
(4)	Sit-ups (2 min)	50	45
(5)	600-yard run	2:00 min	2:15 min

This year, the women's integration panel did not hold a formal session. However Lieutenant Colonel Thomas, panel chairman, initiated a proposal in 1976 to change the Women's PFT flexed-arm-hang to pull-ups. Of the five PFT test items, this was the only test item that differed from men. Approval was granted. Beginning with the past summer program (summer 1978), Class of 1982, women cadets performed pull-ups in lieu of the flexed-arm-hang. Women

cadets in the Classes of 1980 and 1981 started doing pull-ups during the regular PFT cycles (twice a year).

1979 (calendar year):

All cadets were required to take the Physical Fitness Test (PFT) and Aerobics Test each semester, except First Class Cadets. The First Class was required to run the Aerobics Test each semester. The PFT was scheduled and administered by the Physical Education staff. The Aerobics Test was conducted by the individual squadrons. The Evaluation Branch supplied the computer cards, computed the results, and supervised the remedial training. Only on-season intercollegiate athletes, 400/500 club members, and cadets with valid medical excusals were excused from taking the tests. With the exception of 500 club members, all cadets must take the PFT and Aerobics at least once each academic year.

The new PFT minimum standards which took effect this year are as follows:

<u>Fourth Class</u>		<u>Men</u>	<u>Women</u>
(1)	Pull-ups	4	1
(2)	Standing Long Jump	6'8"	5'2"
(3)	Push-ups	26	7
(4)	Sit-ups (2 min)	45	42
(5)	600-yard run	2:10	2:26
<u>Third Class, First Semester</u>		<u>Men</u>	<u>Women</u>
(1)	Pull-ups	6	2
(2)	Standing Long Jump	6'11"	5'5"
(3)	Push-ups	29	9
(4)	Sit-ups (2 min)	50	46
(5)	600-yard run	2:06	2:23
<u>Third Class and Second Class, Second Semester</u>		<u>Men</u>	<u>Women</u>
(1)	Pull-ups	8	3
(2)	Standing Long Jump	7'2"	5'8"
(3)	Push-ups	32	11
(4)	Sit-ups (2 min)	55	50
(5)	600-yard run	2:03	2:20

The minimum standard for the Aerobics Test is the same for all classes: men 11:15 and women 13:31.

This year a four year reconditioning plan was developed and implemented. As a result of this, it was recommended that ten cadets, based on their performance on the PFT, be placed in R-Flight in lieu of summer leave. These ten cadets were reconditioned by AHP and all of them successfully completed the requirements at the end of the R-Flight period.

During 1979, 254 cadets were identified and involved in the Weight Monitoring Program. These cadets were tested for body fat percentages. Results of these tests placed 33 men and 16 women in the "soft core" range (17% to 20% for men, and 27% to 30% for women). These cadets were counseled and placed on a formal weight reduction program.

A second group of 11 men and 4 women were placed in the "hard core" group (men over 20%, and women over 30%). This group was given a physical at the Cadet Clinic and then placed on a reduced caloric diet and enrolled in reconditioning by the Athletic Review Committee. Together the group lost a total of 281 pounds equating to a mean loss of 6.5 pounds per person. The "hard core" men averaged 11 pounds per man weight loss and the "hard core" women averaged 8.3 pounds loss.

A Cadet Reconditioning Program is set up to recondition cadets failing the fall and spring PFT's. In the fall of 1978, 16 cadets were recommended for reconditioning by the Athletic Review Committee. All cadets made good progress and were removed from reconditioning in December. In the spring cycle there were 21 cadets taking part in conditioning activities. Total cadets in conditioning were 24 men and 13 women for the entire year. Last spring 2 women and 5 men were recommended for R-Flight due to PFT failure. All passed at the end of June. In addition to the PFT failures, there were 13 hard core overweight people enrolled for weight reduction. All succeeded in meeting their Air Force maximum standard.

1981 (calendar year):

The following material was extracted from a recent briefing given by the Athletics Department to the Superintendent:

The purpose of the PFT is to measure and determine the fitness level of the Cadet Wing. The test is used to identify physical strengths and weaknesses of cadets, to motivate cadets toward maintaining a high level of physical fitness, and to develop an understanding of the importance of physical fitness to future officers of the United States Air Force.

The PFT is given to the lower three classes once each semester. The test itself is administered over a four-day period with one cadet group scheduled to test each day. Two make-up tests are scheduled during the semester for those cadets who are unable to test during the normal schedule.

The actual test consists of five items: pull-ups, long jump, push-ups, sit-ups, and the 600-yard run, in this order. The test takes fifteen minutes for each cadet to complete. Three minutes are given to each test event; however, the sit-ups test consists of the maximum number of sit-ups a cadet can perform in a two-minute period.

Each test event is scored on a scale of 0 to 100 with the total test worth 500 points.

Class standards include different minimum requirements for each class but the same maximum standards for all classes.

Class minimum standards are:

<u>EVENT</u>	<u>4°</u> [Freshmen]	<u>3°</u> [Sophomores]	<u>2°</u> [Juniors]
MEN			
PULL-UPS	4	6	8
LONG JUMP	6'8"	6'11"	7'2"
PUSH-UPS	26	29	32
SIT-UPS	45	50	55
600-YD RUN	2:10	2:06	2:03
WOMEN			
PULL-UPS	1	2	3
LONG JUMP	5'2"	5'5"	5'8"
PUSH-UPS	7	9	11
SIT-UPS	42	46	50
600-YD RUN	2:26	2:23	2:20

Cadets who achieve the minimum on all items pass the test regardless of their total score. Cadets who fail one item must score 226 points to pass the test. Cadets who fail two or more events fail the test regardless of their points.

Percentile rankings of total points within each class are:

MEN			
<u>SCORE</u>	<u>4°</u>	<u>3°</u>	<u>2°</u>
100	0	0	0
150	0	.4	.73
200	1.7	4.3	5.5
250	7.0	17.4	22.0
300	25.0	43.9	50.6
350	50.8	68.4	74.9
400	71.5	86.5	91.1
450	90.8	97.7	99.1
500	99.9	99.9	99.9

# WOMEN

<u>SCORE</u>	<u>4°</u>	<u>3°</u>	<u>2°</u>
100	0	1.3	1.6
150	0	6.9	1.9
200	6.2	14.3	7.0
250	17.0	35.4	20.5
300	41.6	58.0	48.6
350	60.9	73.3	70.1
400	75.6	82.7	89.1
450	92.1	95.5	95.1
500	99.9	99.9	99.9

Cadets who score 500 points on the PFT are excused from taking the PFT for the rest of their cadet career. In order to score 500 points a cadet must achieve the maximums as shown.

	<u>MEN</u>	<u>WOMEN</u>
PULL-UPS	20	10
LONG JUMP	9'0"	7'10"
PUSH-UPS	65	34
SIT-UPS	85	85
600-YD RUN	1:35	1:53

We are presently in the process of designing and purchasing distinctive T-shirts to give to 500 Club members. 500 Club members will be permitted to wear these shirts to their PE classes or any other PE activity.

Names of 500 Club cadets are displayed on the 500 Club board maintained in the cadet gym.

Cadets who score 400 points on the fall PFT are excused from the spring PFT.

Cadets who fail the PFT receive an "F" in PE 105, 106, etc. All failures are placed on athletic probation. All failures are also reviewed by the Athletic Review Committee for appropriate action. The ARC makes recommendations on special reconditioning, PE R-Flight, and disenrollment.

The fall PFT was given 21-24 September with make-ups given 3 and 24 October. We have an overall failure rate of 2.1%, with a male failure rate of 1.6% and a female rate of 5.8%. These rates are an improvement over past years.

We use past PFT's to understand where cadets now stand physically and whether they are improving or not.

BCT [Basic Cadet Training] PFT results for the four classes now at the academy show a vast decrease in failure rates from the first BCT PFT to the second [Table 3].

TABLE 3. BCT PFT RESULTS, 1978 - 1981

CLASS	BCT TEST	TOTAL			MEN			WOMEN		
		PASS	FAIL	%FAIL	PASS	FAIL	%FAIL	PASS	FAIL	%FAIL
1982	1	1022	347	25.3	952	259	21.4	70	88	55.7
	2	1236	155	11.1	1118	105	8.5	118	50	29.8
1983	1	1046	337	24.4	971	262	21.2	75	75	50.0
	2	1147	94	7.8	1046	73	6.5	101	21	17.2
1984	1	994	532	34.9	914	411	31.0	80	121	60.2
	2	1360	67	4.7	1226	36	2.9	134	31	18.8
1985	1	970	416	30.0	917	300	24.7	53	116	68.6
	2	1177	71	5.69	1078	40	3.71	99	31	28.8

Although acclimatization to the altitude and knowledge of how to take the test account for some of this improvement, the physical conditioning resulting from basic training is readily apparent.

However, even as cadets are removed from the physical rigors of BCT, they still increase in physical fitness. On the fall PFT, all classes had improved drastically over their respective BCT PFT failure rates [Table 4].

By tracing yearly average event scores as well as overall point totals, we can see how physical performance on each event has developed over the last sixteen years of the test [three years for women]. Pull-ups have increased for men from 10 to almost 13. Pull-ups for women have decreased. In the spring 1981 we tightened the administration of individual test items which lowered score averages on that test.

Long jump for both sexes remains very consistent. Push-ups have increased for both men and women with the most marked improvement being with the women [from about 12 to about 28 for the women]. Sit-ups have also improved with both sexes [women improved from about 57 to about 67, equalling men]. Both groups have shown slight increases in their times on the 600-yard run.

In overall point averages, both men and women have shown a steady increase.

TABLE 4. FALL PFT RESULTS BY CLASS

	TOTAL			MEN			WOMEN		
	<u>PASS</u>	<u>FAIL</u>	<u>%FAIL</u>	<u>PASS</u>	<u>FAIL</u>	<u>%FAIL</u>	<u>PASS</u>	<u>FAIL</u>	<u>%FAIL</u>
1983	814	11	1.3	732	8	1.0	82	3	3.6
1984	1034	33	3.2	908	17	1.9	126	16	12.7
1985	1107	20	1.8	959	17	1.8	148	3	2.0

We compared cadet performance on the PFT for the class of 1985 to other men and women throughout the nation. This comparison was made based on the results of national PFT performance given to a comparable age group. We compared the two summer PFTs and the fall PFT to national performance. Even on the first PFT, when the cadet is not acclimated to the altitude, the men score in the 80th percentile or higher on pull-ups, long jump and push-ups. They are above the 50th percentile for sit-ups and are at the 40th percentile on the run. As you can see, cadet performance improves on the second summer PFT and fall PFT. We associate the cadets' lower performance on sit-ups and run to the difference in administration of our test versus the national test. Our test is administered in 15 minutes and the national test is administered in two days with strength items on the first day (pull-ups, push-ups and sit-ups) and endurance items (600-yd run and long jump) on the second day.

For women we were only able to compare three events. The national test for women does not include pull-ups or push-ups. In BCT our women scored at or above the 75th percentile on the long jump and sit-ups. They were at the 44th percentile on the run. We again attribute this to test administration. Our women's performance also improved on the second summer PFT and fall PFT.

We also compared the Wing's mean performance on this fall's PFT to the national rankings. The cadets performed extremely well (80th to 100th percentile) on all items except men's 600-yard run.

We are bringing into the academy cadets who are at a high level of fitness.



The fitness level of cadets appears to have increased over the years from 1964 to present as measured by the PFT.

Cadet performances on the PFT compare very favorably with national PFT performance of a comparable age group.

Current weight standards set by AFMPC/ASD and published in AFR 35-11 (and applicable to all USAF personnel, regardless of age, after 1 November 1981) are shown in Table 5.

TABLE 5. USAF WEIGHT STANDARDS (AS OF NOV 1, 1981)

Men		Women	
Height inches	Maximum	Height inches	Maximum
60	153	58	126
61	155	59	128
62	158	60	130
63	160	61	132
64	164	62	134
65	169	63	136
66	174	64	139
67	179	65	144
68	184	66	148
69	189	67	152
70	194	68	156
71	199	69	161
72	205	70	165
73	211	71	169
74	218	72	174
75	224	73	179
76	230	74	185
77	236	75	190
78	242	76	196
79	248	77	201
80	254	78	206
		79	211
		80	216

#### AEROBICS TEST

The following text from Walter (1970, pp. 4-5) appears to be the best USAFA-generated documentation concerning the introduction of Aerobics testing into the USAFA program.

The United States Air Force has recently completed a study on a new type of physical fitness program. It is a 1.5 miles running test designed by Lt Colonel Kenneth H. Cooper, M.D., USAF. (18) Cooper used Balke's Field Test of Fitness as a foundation for the development of the program. Balke devised a 15-minute field test, in which an individual would run (or walk) as fast as he could for

15 minutes, and at the end of the exercise, his speed measured in meters per minute would be calculated. This value appeared to correlate well with his oxygen consumption established on a treadmill run. (19:33) Cooper modified Balke's test to accommodate the mass population of the Air Force by experimenting with different times in the run/walk and treadmill testing. He settled upon a 12-minute performance test which correlated well with the oxygen consumption data derived from treadmill testing. Cooper then determined that an individual's physical condition could be best evaluated through the measurement of aerobic capacity and cardiovascular endurance by running 1.5 miles in 12 minutes. The resultant program involved a pass or fail type of test with category ratings assigned as a result of performance by various age increments. Conditioning exercises were also developed for those who could not pass the test by means of oxygen consumption tests on the treadmill and/or in the field.

In January 1970, the 1.5 miles test replaced the test outlined in the RCAF 5BX Plan for Physical Fitness (66) as part of the official Air Force physical fitness program. This new program is entitled the USAF Aerobics Physical Fitness Program. (20) The elimination of the 5BX was brought about by the continued high incidence of those diseases involving the heart, lungs, and blood vessels within the Air Force. Further, it was noted that numerous knee and back injuries were incurred during 5BX testing causing the loss of productive man-hours.

In one of Lt Colonel Cooper's original studies of this program, he implied that an increase of strength in all muscles of the body, particularly the arms, was commensurate with increased endurance capacity. (18:6) This was based on data of airmen who could run the mile in less than 8:00 minutes in the 5BX Plan. Of the 30-35% who passed the mile run, 87% could also pass the calisthenic requirements of the 5BX (push-ups, sit-ups, and trunk circles). With training, 97% of these airmen were able to pass the same calisthenic requirement. In studying a group that was able to exceed 1.5 miles in 12:00 minutes, the percentages were even higher, both at the beginning and at the end of training. If this relationship is in fact true, the 1.5 miles test could satisfactorily replace existing physical tests of fitness as an indicator of physical strength as well as endurance.

The Aerobics 1.5 mile test replaced the PFT for First Classmen in 1970, the year Walter completed his dissertation. In his text, Walter went on to thoroughly review the relationship between aerobic training and the development of upper body strength. Walter's data showed, as reiterated by Sampson (1971):

"There was no apparent relationship between the 1.5 miles test and pull-ups or push-ups. Therefore, it was assumed that Cooper's theory on upper arm strength being commensurate with endurance capacity was not valid."

The actual correlation values (apparently Pearson product moment) were in the approximate range of zero to -0.10.

The subsequent integration of the Aerobics test with the PFT was partially documented in the USAFA History, the applicable excerpts of which were presented in the preceding section of this report. In the 1971-72 academic year report, it was noted that First Classmen took the Aerobics test in lieu of the PFT for the second year. Sometime during this period, standard scores were established for the Aerobics test. The distribution and standard scores are reproduced in Table 6 from AHPOI 11-3, Atch 9-3, 18 August 1980.

The sampling of cadets that led to the Aerobics run performance distribution is not documented. The standard score for the Class of 1972, reported in the 1971-72 academic year report indicated an average 1.5-mile time of 11:00 minutes (7:19 per mile) based on the currently published distribution. In the Class of 1975, the cadets averaged 10:17 minutes (6:51 per mile), and in the Class of 1976, 10:03 minutes (6:52 per mile). In calendar year 1976, first semester Second Classmen also took the Aerobics test in lieu of the PFT. That year's report indicates that the Class of 1977 ran the 1.5 miles in 10:08 (6:45 per mile) while the Class of 1978 ran it in 9:54 (6:36 per mile). In calendar year 1977, First and Second Classmen took the Aerobics test in lieu of the PFT. The Class of 1977 ran 10:33 (7:02 per mile) in the spring semester of their senior year, while the Class of 1978 ran 10:06 (6:44 per mile) in the spring and 9:56 (6:37 per mile) in the fall. These are all average times.

In calendar years 1978 and 1979, Fourth through Second Classmen took the Aerobics test and the PFT. First Classmen took only the Aerobics test.

#### PHYSICAL APTITUDE EXAMINATION (PAE)

The PAE is, by far, the most studied and documented of the subjects considered in this report. This section contains excerpts from several investigations of the PAE. The first excerpt was written as a report to the USAFA Commandant of Cadets by Maj W. C. McGlothlin in August 1955. It describes the original structure of the PAE.

#### A Proposed Physical Aptitude Examination:

In the development of the proposed physical aptitude examination, the following criteria have been followed:

- a. The specific test items should sample as many of the basic aspects of physical aptitude as possible -- agility, balance, endurance, flexibility, power, and strength.

TABLE 6. AEROBICS TEST (1.5-MILE RUN) DISTRIBUTION AND STANDARD SCORES.  
Source: AHPOI 11-3, Atch 9-3, USAFA/AH, 18 August 1980. The time criteria for the run are set to exclude the lower 15% of men cadets and lower 3.6% of women cadets. These criteria (men, 11:15; women, 13:31) are much more stringent than those set forth for the 17- to 29-year age group in AFR 35-11 (men, 14:30; women, 15:36).

PFTA SCORES																	
RAW	RAW	STD	RAW	RAW	STD	RAW	RAW	STD	RAW	RAW	STD	RAW	RAW	STD	RAW	RAW	STD
7:45	8:55	500	8:54	10:14	418	10:03	11:33	300	11:12	12:53	202	12:21	14:12	124	13:30	15:32	55
7:46	8:56	499	8:55	10:15	417	10:04	11:35	297	11:13	12:54	200	12:22	14:13	123	13:31	15:33	54
7:47	8:57	498	8:56	10:16	415	10:05	11:36	295	11:14	12:55	199	12:23	14:14	122	13:32	15:34	53
7:48	8:58	497	8:57	10:18	413	10:06	11:37	292	11:15	12:56	198	12:24	14:16	121	13:33	15:35	52
7:49	8:59	496	8:58	10:19	412	10:07	11:38	290	11:16	12:57	197	12:25	14:17	120	13:34	15:36	51
7:50	9:00	495	8:59	10:20	410	10:08	11:39	288	11:17	12:59	195	12:26	14:18	119	13:35	15:37	50
7:51	9:01	494	9:00	10:21	408	10:09	11:40	287	11:18	13:00	194	12:27	14:19	118	13:36	15:38	49
7:52	9:03	493	9:01	10:22	407	10:10	11:41	285	11:19	13:01	193	12:28	14:20	117	13:37	15:40	48
7:53	9:04	492	9:02	10:23	405	10:11	11:43	283	11:20	13:02	192	12:29	14:21	116	13:38	15:41	47
7:54	9:05	491	9:03	10:24	404	10:12	11:44	282	11:21	13:03	190	12:30	14:23	115	13:39	15:42	46
7:55	9:06	490	9:04	10:26	402	10:13	11:45	280	11:22	13:04	189	12:31	14:24	114	13:40	15:43	45
7:56	9:07	489	9:05	10:27	400	10:14	11:46	278	11:23	13:05	188	12:32	14:25	113	13:41	15:44	44
7:57	9:09	488	9:06	10:28	398	10:15	11:47	277	11:24	13:07	187	12:33	14:26	112	13:42	15:45	43
7:58	9:00	487	9:07	10:29	397	10:16	11:48	275	11:25	13:08	185	12:34	14:27	111	13:43	15:46	42
7:59	9:11	486	9:08	10:30	395	10:17	11:50	273	11:26	13:09	184	12:35	14:28	110	13:44	15:48	41
8:00	9:12	485	9:09	10:31	393	10:18	11:51	272	11:27	13:10	183	12:36	14:29	109	13:45	15:49	40
8:01	9:13	484	9:10	10:32	392	10:19	11:52	270	11:28	13:11	182	12:37	14:31	108	13:46	15:50	39
8:02	9:14	483	9:11	10:34	390	10:20	11:53	268	11:29	13:12	180	12:38	14:32	107	13:47	15:51	38
8:03	9:15	482	9:12	10:35	388	10:21	11:54	267	11:30	13:14	179	12:39	14:33	106	13:48	15:52	37
8:04	9:17	481	9:13	10:36	387	10:22	11:55	265	11:31	13:15	178	12:40	14:34	105	13:49	15:53	36
8:05	9:18	480	9:14	10:37	385	10:23	11:56	263	11:32	13:16	177	12:41	14:35	104	13:50	15:54	35
8:06	9:19	479	9:15	10:38	383	10:24	11:58	262	11:33	13:17	175	12:42	14:36	103	13:51	15:56	34
8:07	9:10	478	9:16	10:39	382	10:25	11:59	260	11:34	13:18	174	12:43	14:37	102	13:52	15:57	33
8:08	9:21	477	9:17	10:41	380	10:26	12:00	259	11:35	13:19	173	12:44	14:39	101	13:53	15:58	32
8:09	9:22	476	9:18	10:42	378	10:27	12:02	258	11:36	13:20	172	12:45	14:40	100	13:54	15:59	31
8:10	9:23	475	9:19	10:43	377	10:28	12:03	257	11:37	13:22	170	12:46	14:41	99	13:55	16:00	30
8:11	9:25	474	9:20	10:44	375	10:29	12:05	255	11:38	13:23	169	12:47	14:42	98	13:56	16:01	29
8:12	9:26	473	9:21	10:45	373	10:30	12:06	254	11:39	13:24	168	12:48	14:43	97	13:57	16:03	28
8:13	9:27	472	9:22	10:46	372	10:31	12:07	253	11:40	13:25	167	12:49	14:44	96	13:58	16:04	27
8:14	9:28	471	9:23	10:47	370	10:32	12:08	252	11:41	13:26	165	12:50	14:45	95	13:59	16:05	26
8:15	9:29	470	9:24	10:49	368	10:33	12:09	250	11:42	13:27	164	12:51	14:47	94	14:00	16:06	25
8:16	9:20	469	9:25	10:50	367	10:34	12:10	249	11:43	13:28	163	12:52	14:48	93	14:01	16:07	24
8:17	9:32	468	9:26	10:51	365	10:35	12:11	248	11:44	13:30	162	12:53	14:49	92	14:02	16:08	23
8:18	9:33	467	9:27	10:52	363	10:36	12:13	247	11:45	13:31	160	12:54	14:50	91	14:03	16:09	22
8:19	9:34	466	9:28	10:53	362	10:37	12:14	245	11:46	13:32	159	12:55	14:51	90	14:04	16:11	21
8:20	9:35	465	9:29	10:54	360	10:38	12:15	244	11:47	13:33	158	12:56	14:52	89	14:05	16:12	20
8:21	9:36	464	9:30	10:56	358	10:39	12:16	243	11:48	13:34	157	12:57	14:54	88	14:06	16:13	19
8:22	9:37	463	9:31	10:57	357	10:40	12:17	242	11:49	13:35	156	12:58	14:55	87	14:07	16:14	18
8:23	9:38	462	9:32	10:58	355	10:41	12:18	240	11:50	13:36	155	12:59	14:56	86	14:08	16:15	17
8:24	9:40	460	9:33	10:59	353	10:42	12:19	239	11:51	13:38	154	13:00	14:57	85	14:09	16:16	16
8:25	9:41	459	9:34	11:00	352	10:43	12:21	238	11:52	13:39	153	13:01	14:58	84	14:10	16:17	15
8:26	9:42	458	9:35	11:01	350	10:44	12:22	237	11:53	13:40	152	13:02	14:59	83	14:11	16:19	14
8:27	9:43	457	9:36	11:02	348	10:45	12:23	235	11:54	13:41	151	13:03	15:00	82	14:12	16:20	13
8:28	9:44	455	9:37	11:04	347	10:46	12:24	234	11:55	13:42	150	13:04	15:02	81	14:13	16:21	12
8:29	9:45	454	9:38	11:05	345	10:47	12:25	233	11:56	13:43	149	13:05	15:03	80	14:14	16:22	11
8:30	9:47	453	9:39	11:06	343	10:48	12:25	232	11:57	13:45	148	13:06	15:04	79	14:15	16:23	10
8:31	9:48	452	9:40	11:07	342	10:49	12:26	230	11:58	13:46	147	13:07	15:05	78	14:16	16:24	9
8:32	9:49	450	9:41	11:08	340	10:50	12:27	229	11:59	13:47	146	13:08	15:06	77	14:17	16:26	8
8:33	9:40	449	9:42	11:09	338	10:51	12:29	228	12:00	13:48	145	13:09	15:07	76	14:18	16:27	7
8:34	9:51	448	9:43	11:10	337	10:52	12:30	227	12:01	13:49	144	13:10	15:08	75	14:19	16:28	6
8:35	9:52	447	9:44	11:12	335	10:53	12:31	225	12:02	13:50	143	13:11	15:10	74	14:20	16:29	5
8:36	9:53	445	9:45	11:13	333	10:54	12:32	224	12:03	13:51	142	13:12	15:11	73	14:21	16:30	4
8:37	9:55	444	9:46	11:14	332	10:55	12:33	223	12:04	13:53	141	13:13	15:12	72	14:22	16:31	3
8:38	9:56	443	9:47	11:15	330	10:56	12:34	222	12:05	13:54	140	13:14	15:13	71	14:23	16:32	2
8:39	9:57	442	9:48	11:16	328	10:57	12:36	220	12:06	13:55	139	13:15	15:14	70	14:24	16:34	1
8:40	9:58	440	9:49	11:17	327	10:58	12:37	219	12:07	13:56	138	13:16	15:15	69			
8:41	9:59	439	9:50	11:18	325	10:59	12:38	218	12:08	13:57	137	13:17	15:17	68			
8:42	10:00	438	9:51	11:20	323	11:00	12:39	217	12:09	13:58	136	13:18	15:18	67			
8:43	10:01	437	9:52	11:21	322	11:01	12:40	215	12:10	13:59	135	13:19	15:19	66			
8:44	10:03	435	9:53	11:22	320	11:02	12:41	214	12:11	14:01	134	13:20	15:20	65			
8:45	10:04	434	9:54	11:23	318	11:03	12:42	213	12:12	14:02	133	13:21	15:21	64			
8:46	10:05	432	9:55	11:24	317	11:04	12:44	212	12:13	14:03	132	13:22	15:22	63			
8:47	10:06	430	9:56	11:25	315	11:05	12:45	210	12:14	14:04	131	13:23	15:23	62			
8:48	10:07	429	9:57	11:26	313	11:06	12:46	209	12:15	14:05	130	13:24	15:25	61			
8:49	10:08	427	9:58	11:28	312	11:07	12:47	208	12:16	14:06	129	13:25	15:26	60			
8:50	10:09	425	9:59	11:29	310	11:08	12:48	207	12:17	14:08	128	13:26	15:27	59			
8:51	10:11	424	10:00	11:30	307	11:09	12:49	205	12:18	14:09	127	13:27	15:28	58			
8:52	10:12	422	10:01	11:31	305	11:10	12:50	204	12:19	14:10	126	13:28	15:29	57			
8:53	10:13	420	10:02	11:32	302	11:11	12:52	203	12:20	14:11	125	13:29	15:30	56			

Aerobics Minimums

Men - 11:15

Women - 13:31

b. The specific test times should sample the basic aspects of physical aptitude by means of a variety of types of activity using as many different muscle groups as possible.

c. The specific test items should stand the test of basic research with respect to validity, reliability, objectivity, and the establishment of norms.

Although this study proposes five specific test items for the Physical Aptitude Examination, it is not to be assumed that these five test items will continuously be used. To the contrary, the test items will be changed periodically to prevent prospective candidates for admission to the United States Air Force Academy from practicing for the test and thus invalidate the data.

The five items for the initial physical aptitude examination have been selected on the basis of a factor analysis study (Div. of PR A00. Department of Army. Graphs of study on file in Department of Physical Training, United States Air Force Academy) of 35 physical performance test items prepared by the Division of Personnel Research, Adjutant Generals Office, Department of the Army, which meet adequate validity requirements. The data used in developing this factor analysis was supplied by the Office of Physical Education, United States Military Academy.

Table 7 below represents an analysis of the test items. (See Tab 0 for description of test items.)

TABLE 7. TEST ITEM ANALYSIS

Item	Areas of Body Used	Component Tested	Reliability Under Mass Testing Situations
1. Pullups	Arms & Shoulders	Endurance	.9
2. Hop, Skip & Jump	Total Body	Coordination	.85
3. 150 Yd Shuttle Run	Total Body with Leg Emphasis	Speed	.83
4. Mod. Basketball Throw	Arms & Torso	Power	.86
5. Hurdle Run	Total Body with Leg Emphasis	Coordination	.8

Administrative Feasibility of a Physical Aptitude Examination--The fact that physical aptitude examinations have been administered successfully by other institutions is indication enough that the Air Force Academy can administer a valid and reliable physical aptitude examination. Some of the factors which demonstrate the administrative feasibility of the proposed physical aptitude examination (Tab G) for the Air Force Academy are as follows:

a. The proposed physical aptitude examination can be administered in approximately 60 minutes.

b. Air Force gymnasium facilities at Testing Centers can be used.

c. Scoring of tests and analysis of data can be machine computed by the Department of Statistical Services, United States Air Force Academy.

Conclusions--It is concluded that a physical aptitude examination is a necessary part of the entrance examinations for candidates to the Air Force Academy and should be initiated as soon as possible.

The PAE has undergone several changes over the years. The current version of the examination is depicted in Figure 1, taken from the 1981-82 USAFA catalog.

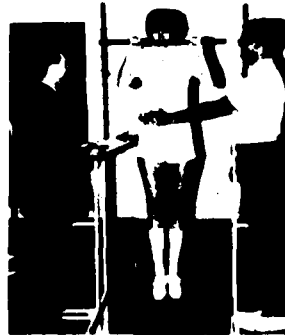
The PAE was implemented as a screening device by USAFA in 1955, after it was developed for the United States Military Academy (USMA, West Point) in 1949 by Appleton. The PAE minimum standard score of 400 was set in 1963, excluding approximately the lower 16% of candidates taking the test. The flexed-arm hang was instituted for women candidates because they generally cannot do pull-ups. This lack produced no statistical variance in pull-up performance to which selection criteria could be applied. Women can generally perform the flexed-arm hang well enough to produce a performance distribution wide enough to allow the discrimination of good from bad performers.

# PHYSICAL APTITUDE EXAMINATION ITEMS

Candidates are advised to prepare for this exam by engaging in vigorous physical activities and by practicing on specific items. The items included in this examination are listed below.



**PULLUPS (Men)**—From a momentary hang position on a horizontal bar, palms away from face, elevate the body until chin is above the bar. Return to straightarm hang position and repeat as many times as possible.



**FLEXED ARM HANG (Women)**—You are positioned by means of an elevating device (step ladder, platform, etc.) so that your chin is above the bar, your elbows are flexed, and your chest is close to the bar. Use an overhand grasp, palms away from body, and maintain a chin-above-bar position as long as possible.



**300 YARD SHUTTLE RUN**—Run six round trips between two turning lines, 25 yards apart, in the shortest time possible.



**STANDING LONG JUMP**—From a standing position behind a take-off line, jump forward as far as possible. Swinging arms, bending knees, and raising heels off the floor is allowed, but do not take a preliminary step or hop.



**BASKETBALL THROW**—From a kneeling position on a mat, throw a basketball overhead to attain as great a distance as possible. Three throws are allowed from behind the throwing line.

Below are the PAE ranges of scores for men and women cadets in a recent entering class:

	<i>Flexed</i>		<i>Standing</i>		<i>Basketball</i>		<i>300 Yard</i>	
	<i>Pull</i>	<i>Arm</i>	<i>Long Jump</i>		<i>Throw</i>		<i>Shuttle Run</i>	
	<i>Ups</i>	<i>Hang</i>	<i>M</i>	<i>W</i>	<i>M</i>	<i>W</i>	<i>M</i>	<i>W</i>
High Scores	29	88 sec	9' 9"	7' 9"	105'	61'	45.8 sec	58 sec
Mean Scores	10.6	27.7 sec	7' 11"	6' 3"	70'	40'	58.8 sec	68.7 sec
Low Scores	1	1 sec	6' 2"	4' 10"	36'	19'	71 sec	85 sec

Figure 1. Illustration of PAE events (from 1981-82 USAFA Catalog, page 77).

Walter, 1970

The following text, from Walter's (1970) "Summary, Conclusions, and Recommendations" chapter, explains his basic experimental approach and describes the statistical nature of the PAE. These remarks also address the relationship of the PAE to the PFT and Aerobics run. Unfortunately, some of the PAE test items examined by Walter are no longer used in the PAE.

Summary--The purpose of this study was to recommend a physical proficiency testing program for the USAF Academy, based on the results of investigating the relationship between the USAF Academy's Candidate Physical Aptitude Examination, the USAF Academy's Physical Fitness Test, and the Air Force's physical fitness program, involving aerobic exercises. In an attempt to resolve the problem, 200 cadets in the Class of 1973 were randomly sampled and administered each test twice. The obtained data were statistically treated by means of the Burroughs B5500 computer to analyze test items involving more than one trial, to determine the reliability of the tests, to analyze the relationship of each test with one another, and to analyze the relationship of the tests which selected variables, such as age, height, weight, the ponderal index, body surface area, the athletic activities index, residual index, and the drop-off index.

In scoring multi-trial test items for the PAE and the PFT, the USAF Academy had been using the best score of the trials to add to the composite score of the appropriate test. Analysis of the multi-trial test items by means of the intraclass correlation technique revealed that the average scores in the best grouping of trials should probably be used as the criterion measure. For the PAE hop-step and jump and the PAE medicine ball throw, trial 2 and trial 3 appeared to be the best grouping of consecutive trials. The effect of learning was evident in analyzing all three trials and produced significant trial-to-trial variation. For the PFT standing broad jump, the average of all three trials appeared as the appropriate criterion measure.

All three tests, the PAE, the PFT, and the 1.5 miles test, were found to be reliable by utilizing the test-retest design and comparing the results by zero-order correlation and multiple correlation technique. The high correlation between the tests and their criterion measure was evidence of validity since both the test and the criterion were found to be reliable. Further comparisons between the tests were made in order to select the most reliable or stable test data to proceed into the study. By analysis of the means, variance, and the coefficients of correlation between the tests, the retest of the PAE, the initial test of the PFT, and the initial test of the 1.5 miles test were selected.



Investigation of the PAE revealed that three of the five test items used in deriving the PAE composite score were apparently measuring motor ability or motor aptitude. These items, the zig zag run, hop-step and jump and the 300 yard shuttle run, related well to one another and to the PAE composite score. Also, it was found that the zig zag run and the hop-step and jump had some effect on the variance in the PAE composite score. While the medicine ball throw was also a skill type of test time, it did not relate as favorably. Pull-ups, the fifth test item, appeared independent of the other test items. In contrast, the PFT analysis revealed little or no relationship between its test items, indicating that the test items were apparently measuring different factors, such as muscular strength, muscular endurance, and power. Pull-ups and push-ups were found to be the most influential test items in contributing to the variance of the PFT composite score. The PAE and PFT did relate favorably to each other, however, the test batteries contained several common test items.

The Air Force 1.5 miles test, a test designed to measure cardiovascular endurance capacity, showed little or no relationship to either the PAE or PFT. Of the two tests, the 1.5 miles test related slightly better to the PFT, perhaps due to the PFT administrative procedures and the presence of the 600 yard run in the PFT battery. The findings were basically in agreement with the literature with regard to cardiovascular endurance tests and tests designed to measure muscular strength. (16:113, 27:36) The findings were also in direct opposition to Cooper's premise that strength in all the muscles of the body, particularly the arms, was commensurate with endurance capacity. (18:6)

In summarizing the relationship of the three tests to the selected variables, such as age, height, weight, the ponderal index, body surface area, the athletic activities index, residual index, and the drop-off index, it was found that the relationships were low and, in some instances, not significant. Specifically, there was no relationship evident between age and the tests. Where leverage and force were involved in the mechanics of performing a test item, height and weight showed some degree of relationship with that item. The ponderal index and body surface area, as possible body classifiers, appeared no better than height or weight individually. Except for pull-ups, the athletic activities index related low, but significantly, with the other test items of the PAE and PFT. The athletic activities index related slightly better with the PAE than it did with the PFT. The relationship of the residual index and the drop-off index with the 1.5 miles test was found to be low, but significant. However, the coefficients of correlation obtained

were slightly higher than previously reported in the literature. (36:43)

Conclusions--The conclusions of this study are as follows:

1. The use of the average score of the appropriate trial grouping as the criterion measure appeared to be the proper method for scoring the hop-step and jump, the medicine ball throw and the standing broad jump. Using the best performance as the criterion measure may in fact measure learning to perform the test, rather than the physical factor(s) sought.

2. The three tests analyzed, the PAE, the PFT, and the 1.5 miles tests, are reliable tests. Their continued use is justified, for they appeared to consistently measure the criteria for which they were designed.

3. On the basis of its relationship with the 1.5 miles test, it may be concluded that the PAE does not measure cardiovascular endurance. However, the measurement of cardiovascular endurance is not necessarily essential to meet the criteria for selection of prospective cadets for the USAF Academy.

4. Some relationship did exist between the 1.5 miles test and the PFT. The measurement of cardiovascular endurance may be of greater importance in the evaluation of the USAF Academy's physical education program.

5. It may be concluded that muscular strength, particularly in the arms, is not necessarily commensurate with cardiovascular endurance capacity. The test items in the PAE and PFT designed to measure the muscular strength of the arms, such as pull-ups, showed no relationship with the 1.5 miles test.

6. The physique type of classification device that involves height and/or weight as used in this study appeared to be of little value. Cadets may generally be considered to be a homogeneous group with regard to physical characteristics because of the initial selection criteria.

7. The athletic activities index showed some relationship to the PAE, which was comprised of more skill-type test items. However, the derivation of the athletic activities index may not possess enough objectivity to properly appraise athletic ability and relate to the PAE and/or PFT.

8. While some evidence of relationship was apparent between the residual index and the drop-off index and the 1.5 miles test, the indices did not sufficiently measure the quality of cardiovascular endurance as found in prolonged running. There are physiological as well as psychological limitations in running, and this appears to be part of the problem.

Recommendations--On the basis of the findings and conclusions of this study, the following recommendations are submitted:

1. Multi-trial test items selected for use in the PAE should be statistically analyzed to determine whether the best score of the average scores should be used for scoring the test. It is recommended that this be a continuous study and accomplished prior to the design of a PAE battery of test items for any given year.

2. For the PFT standing broad jump, it is recommended that the use of three trials be continued and the average score of these trials be used as the basis for scoring in the future.

3. The PAE should justifiably be continued. It measures what it is purported to measure. Careful evaluation of test items is essential and should be continued. It is recommended that in the future the PAE include pull-ups, an agility or speed run, such as the zig zag run or hurdle run, a jumping test item, such as the standing broad jump, and a general endurance run, such as a shuttle run of 300 yards or better. The above test items are easy to administer and relate best to the criteria deemed essential for selection of prospective cadets for the USAF Academy.

4. The PFT should justifiably be continued. It measures what it is purported to measure. The PFT related sufficiently to the Air Force's 1.5 miles test to warrant consideration for use as part of the USAF Academy's physical education program. Specifically, it is recommended that it replace the PFT in the first class year, and/or replace the PFT as early as the spring semester of the second class year. Such a change may alleviate the historic decline in physical performance in the first class year and prepare cadets for the Air Force as participants and/or supervisors in the program.

5. The physique or body type of indices used in this study did not satisfy the need for the tests used. However, it is recommended that anthropometric measurement studies be developed to fulfill this need.

6. The running indices used in this study showed some improvement in measuring cardiovascular endurance. Further study of these indices with cardiovascular endurance tests seems essential. It is recommended that in deriving the indices, all out efforts in medium distance running be used, such as 440 yards and 880 yards.

The following text, reproduced in whole, is a careful consideration of all available PAE research through 1971. Its existence should prevent unnecessary duplications of research efforts and guide us in our design of new testing procedures, if required.

A Synthesis of Air Force Academy Physical  
Aptitude Examination Research  
by  
Orwyn Sampson  
May 1971

I. PURPOSE

The Air Force Academy has used the Physical Aptitude Examination as a candidate selection criterion for sixteen years. During that time, numerous studies were carried out which examined, or attempted to examine, such questions as:

1. What should this test do for us?
2. How well does it accomplish its purpose?
3. How can it be improved?

The purpose of this monogram was to synthesize available USAFA Physical Aptitude Examination studies and attempt to learn what these studies reveal in terms of the questions listed above. It is believed that a Physical Aptitude examination research synthesis would be of value in several ways:

1. It would tie together numerous individual studies which have covered the same ground but in a slightly different manner.
2. It would provide the investigator with a ready anthology of research relating to the Physical Aptitude Examination.
3. It would prevent needless redundancy and give direction to future research efforts.

This paper is divided into three major areas with the following headings:

1. Why the PAE?
2. How effective is the PAE?
3. How can it be improved?

## II. WHY THE PAE?

### A. Background

The Physical Aptitude Examination, colloquially called the PAE, is one of several candidate selection tests administered to young men seeking appointment to the United States Air Force Academy. It was patterned after a similar test used at the United States Military Academy.

Five to six individual test items have been used to comprise the PAE for any given year. These test items are selected from a battery of approximately twenty test items, each designed to test either a different aspect of physical aptitude, or the same aspect, but in a different manner. The entire battery is listed in the USAFA Catalogue.

For many years, one item on a six-item test would be used solely for research purposes to gain information in terms of validity, reliability, and objectivity. Additionally, the test items were changed each year to "reduce the learning effect." In more recent years, these practices were changed (20, 61). (Numbers in parentheses refer to the numerical listing of references in the bibliography.)

The responsibility for administering the PAE was given to the Air Force Academy and Aircrew Examining Centers located at nearly seventy-five Air Force bases around the world (23,25). To insure standardized testing, Annual World-Wide Conferences of Air Force Academy and Aircrew Examining Center Personnel were held at the Air Force Academy. These conferences began in 1956 and continued until 1962 at which time the recommendation was made to send Department of Physical Education personnel to selected bases each year to conduct PAE clinics. The cost to USAFA for this program is approximately \$2,000 per year (61).

The PAE is administered to candidates at the base gymnasium of the Air Force installation to which they are assigned for medical testing. It requires approximately one and one-half hours to administer and is given by personnel trained in accordance with the USAFA PAE Manual.

Several significant changes in the PAE have been seen since 1966. Originally, the test accounted for only \*% of the final selection composite. This was raised to \*% in 1961 when the AFQT was dropped (19). In 1960, the standard scores for zero pull-ups and chins were changed from 322 and 274, respectively, to 200 thereby making it more difficult for a weak candidate to receive an appointment (9). In addition, the minimum composite PAE score for an appointment was raised from 350 in 1956 to 400 in 1963 (30). The standard score scale used for the PAE ranges from 200 to 800 with a candidate mean of 500 points.

In the early sixties two important changes were developing, both in response to budgetary considerations. An interest in joint service academy testing to avoid duplication of effort (39) and a desire to develop a simplified PAE (47,35,43) were generated.

#### B. Need

In 1955, the same year the first class entered the Air Force Academy, a report was submitted to higher headquarters which requested the establishment of a Candidate Physical Aptitude Examination (68). That report included the following definitions which will be adhered to throughout this paper:

1. Physical Aptitude: A predictive measure of an individual's capacity to acquire a satisfactory level of physical ability.

2. Physical Ability: That degree of capability an individual possesses in order to perform activities associated with (a) accomplishing military duties, (b) maintaining good health and physical condition, and (c) leading an active recreational life with respect to these definitions, it must be remembered that physical aptitude is a capacity for acquiring physical ability; this capacity is inferred from a score received on a performance-type test. How effectively this is accomplished is examined in a later part of the paper.

The need for a candidate PAE was felt early in the Academy's development. Much of the need was addressed from experience gained at the United States Military Academy after nearly a decade of such testing. (Dr. Lloyd Appleton originated the PAE at the USMA and later summarized the program in a doctoral dissertation completed at New York University in 1949.)

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Justification for the PAE appeared in many forms (26, 31, 39, 61) and suggested monetary savings to the Air Force and better identification of successful cadets in terms of their ability to graduate, their physical education performance, and their leadership ability.

Financially, it was estimated that savings of \$60,000 per year would be realized by eliminating those candidates weak in physical aptitude. It was pointed out that numerous programs, such as Army Ranger and Airborne Training, other service academies, various city and state police departments, and physical education schools, use a physical aptitude screening of their candidates. It is strongly believed that considerable amounts of time and money would be wasted in an attempt to develop a physically substandard individual for a highly active assignment (39). More is said on this subject under the section dealing with attrition.

In a policy statement printed in 1964, Owens (26) summarized the justification for the PAE as follows:

1. Graduates must possess a relatively high degree of physical aptitude to perform their duties as commissioned officers. This is especially true of graduates seeking rated status. A Candidate Physical Aptitude Examination identifies individuals low in this area.
2. There is a significant positive correlation between Physical Aptitude Scores and success or failure to graduate from the Air Force Academy.
3. The Physical Aptitude Examination has been shown to be a measure of leadership potential at both the Air Force Academy and the Military Academy. (L. E. Owens, Memorandum for Record, "An Air Force Academy Stand on Physical Aptitude Examination as a Qualifying Factor for Candidates," 3 March 1964)

From the above, it is evident that a need for establishing a physical aptitude screening test exists. How effectively has the PAE fulfilled this need?

### III. HOW EFFECTIVE IS THE PAE?

#### A. Validity

Validity of a test refers to its integrity; it is a measure of how well the test accomplishes what it was designed to accomplish. As far as the PAE is concerned, it was designed to assess the capacity of a candidate to acquire physical ability. To determine the PAE's

validity, then, requires a correlation between PAE performance and some variable which measures the acquisition of physical ability. The most commonly used variable for this purpose is physical education success. Since the inspection of the PAE, however, it has been useful in other areas; e.g., in predicting leadership and attrition.

### 1. Physical Education Success

Fourteen studies were found which correlated PAE performance with physical education success (1, 8, 10, 15, 20, 24, 30, 36, 45, 49, 52, 58, 62, 67). Some of these studies presented no new data. Ten studies reported correlations between the PAE composite score and fourth class physical education grade (See [Table 8]). These correlations ranged in magnitude from .38 to .74. The higher correlations are spuriously high as PAE performance was included as part of the physical education grade for the first three classes. When taken into consideration, the aggregate correlation from all the data presented would probably be around .50. This is not too bad considering the fact that there is no other selection variable which predicts its criterion measure any better (30).

Only five studies (15, 45, 49, 58, 62) could be found which related overall PAE performance to individual physical education subject success; and, since only the fourth class year was examined, only four subjects appeared in the analyses. These findings are presented in [Table 9]. In general, they show that swimming correlates the worst with PAE of all subjects. This is not surprising as it is obvious that many factors in addition to physical aptitude determine an individual's performance on a swimming test (e.g.; availability of swimming facilities, fear, amount of training, etc.)

Individual PAE test items have been correlated with physical education success both for individual subjects and for overall grade (20, 49, 52, 58, 62, 67). A summary of the findings is presented in [Table 10]. As has been pointed out by Owens (24), chin-ups and pull-ups appear to be the best individual predictors of achievement in physical education. Some of the items with fair predictability include the hurdle run and shuttle runs while the vertical jump and the hop, step, and jump test are the poorest predictors.

### 2. Leadership

Measuring leadership at the Air Force Academy has been accomplished through several means which are all related. These include Cadet Evaluation Ratings (CER), Military Order of Merit (MOM), and Aptitude for Commissioned Service (AFCS). These ratings are similar in that



each is comprised of an evaluation by peers and superiors of the individual's potential for leadership.

Ten studies contributed data relating the PAE and leadership [Table 11]. A review of these studies reveals that there is a positive correlation between the variables. The magnitude of the correlations ranges from .13 to .32.

In addition to the correlational analyses, several other studies have demonstrated the relationship between PAE and leadership (10, 36, 45).

### 3. Attrition

As Richarz (32) points out, emphasis at the Air Force Academy has shifted from pure academic selection criteria to a combination of academic and non-academic criteria in predicting success. This change has greatly improved the Academy's ability to predict success and failure.

Attrition, or more correctly, its reciprocal, ability to graduate, has been used as a measure of success at the Air Force Academy. Several investigators have turned to the PAE in an attempt to predict this factor (34, 5, 16, 32, 53, 57, 61, 63, 64, 66). Their findings are not as clearcut as is the case for physical education and leadership. Several studies show a higher attrition rate for cadets at the low end of the PAE Scale (2, 3, 4, 7, 16, 61, 63) than their classmates. Two studies, however, suggest that the relationship between these variables may be curvilinear (64,66) as there is evidence that the attrition percentage increases at both ends of the PAE scale.

One investigator came to the conclusion that there is no direct correlation between PAE scores and attrition (5). This conclusion, as has been indicated, may also be premature. Additional investigation is needed before a position can be taken with confidence.

Before leaving this subject, a word should be given regarding cut-off scores on the PAE. Originally the minimal score permissible was 350 (54). This eliminated approximately the bottom 7%. For the Class of 1967, the minimum score was raised to 400 (10-15%) and has remained there ever since. Several studies have been directed at this problem (2, 17, 40, 41, 54).

## B. Reliability

Reliability, although not a criterion of Academy success is extremely critical from a test administration standpoint. If a test (or test item) is reliable, we know that it has good reproducibility. In terms of test administration, this means that the procedures are standardized to such an extent that every candidate is treated fairly and no biases are introduced. This idea is emphasized at all PAE Clinics:

### Briefing Guide, PAE Clinic, 1963

Reasons why you are conducting the clinic:

1. PAE is given to about 5,000 candidates at approximately 62 different Examining Centers.

2. About 8 to 16% of those candidates who score the least points are disqualified.

3. Of the remaining candidates, the score made on the PAE will either help or hinder their chances of selection as a cadet.

4. Since we all want only the best candidates as cadets and future officers, standardization in the administration of the PAE is very important. It is of vital importance that if candidate John Jones on a given day can perform 5 pull-ups, run the shuttle-run in 62 seconds, and do 7 feet in the standing broad jump, he would receive these scores wherever he was tested that day---in Iowa, Alaska, Hawaii, Nebraska, et cetera. Faulty measurement, counting or timing may allow a less qualified candidate to enter the Air Force Academy over a better qualified young man.

5. The mere fact that you administer the PAE consistently is not the answer. Not only must you administer it consistently, but you must administer each test item exactly as it is done at 62 other Centers. That is, the medicine ball must weigh exactly 6 pounds, extra motivation and coaching must not be given, etc.

One study compared the results of a PAE administered by high school physical education teachers, with no formal PAE test administration training, with the standardized PAE administered at Air Force Academy and Aircrew Examining Centers (29). The results showed that the high school test introduced considerable variance and, thereby, reduced its reliability.

In addition to standardized testing procedures, reliability implies a certain level of consistency within

each test item. In other words, similar results are obtainable with repeated administrations of the test. If a test introduces bias or has considerable room for error, it will not show good reliability.

[Table 12] shows the reliability figures obtained from three studies (38, 46, 51). Basically, these correlations show that most of the PAE test items are fairly reliable. One test, however, the 180 yard block shuttle run, yielded a test-retest coefficient of only .43. This test would not be a good item to include in a PAE battery.

### C. Other Studies

An extensive number of additional studies have been carried out on the PAE. Many of these have included intercorrelations between the test items (38, 46, 50, 51, 56, 65, 67). The data they present show what one might expect; i.e., that running items correlate high with each other, as do agility and jumping tests. (See [Table 13])

A few studies have attempted to compare PAE performance by cadets with other groups. Owens (21) discovered that from 65% to 75% of the cadets in Classes 61 to 65 scored higher than 500 on the PAE. He reinforced his belief that the cadet population was above average physically by means of the AAHPER Youth Fitness Test (22).

Although he presented no statistics other than mean scores, Hawkins (13) showed that USAFA cadets were superior to USMA cadets on seven out of nine PAE test items.

A number of studies have compared athletes and non-athletes in terms of PAE performance (11, 14, 16, 18, 28, 44). The consistent finding that athletes are superior to non-athletes on the PAE is not surprising. The exact relationship between these variables in some of the studies, however, is hidden because of inexplicit assignment of the subjects to the various groups ("who is an athlete?")

Walter (44), Kardach (14), and Oehrlein and Eichin (18) compared sports and found that they can be distinguished from each other on the basis of the PAE.

Harris (12) found that poor swimmers scored significantly lower on the PAE than did good swimmers.

Numerous attempts have been made to relate the PAE with academic success (15, 14, 5, 28, 30, 48) but to no avail. What these investigators have overlooked is the relationship between these variables at given levels of intelligence (reference Rogers, Hart and Shay; Doornik; and Others).

Delaino (6) examined PAE pull-up performance of weak entering cadets to determine what impact, if any, the Basic Cadet Training program had on improving strength. He found that 63% of these unable to perform three pull-ups on the PAE improved their strength during the two-month BCT; 13% remained the same; 6% did poorer; and 18% were medically excused.

Walter (46) carried out an interesting comparison between the PAE, the Cadet PFT (Physical Fitness Test), and the Aerobics (1.5 Mile run). He obtained correlations between the PAE and the PFT ranging from .55 to .62. These are somewhat higher than previously reported but the test batteries were more identical than they had been in the past. Walter found little or no correlation between the PAE and the 1.5 mile run.

In elaborating on his findings, he states:

"There was no apparent relationship between the 1.5 miles test and pull-ups or push-ups. Therefore, it was assumed that Cooper's theory on upper arm strength being commensurate with endurance capacity was not valid. (H. J. Walter, "A Critical Analysis of the United States Air Force Academy's Physical Proficiency Testing Programs," Unpublished doctoral dissertation, University of Indiana, 1970, pp 89-90)

In an attempt to develop a formula for deriving a PAE score for a candidate unable to take the test, Wheeler, Dworaczyk and Wetzler (55) carried out an extensive regression analysis of all selection variables plus high school physical education grades and certain anthropometric variables. They ultimately derived a formula based on athletic index and high school physical education grade that would yield a fairly reliable PAE score.

#### IV. HOW CAN IT BE IMPROVED?

##### A. Summary and Discussion

From the foregoing, it is clear that the PAE is related to physical education success and to leadership. The correlations presented, although not sufficiently high to afford direct prediction are at least as good as those offered by any other selection variable.

The question of how well the PAE predicts ability to graduate deserves more attention. A considerable amount of research energy has been directed at the low end of the PAE scale. Perhaps an investigation of PAE performance by "reason for discharge" might prove profitable.

In spite of the fact that numerous investigators have shown little or no relationship between the PAE and academic success, others have discovered a relationship between physical fitness and academic performance when IQ or verbal aptitude score were held constant. Should the same relationship exist between the PAE and GPA, it would indicate that the level of a person's physical ability for his level of intelligence will greatly influence how well he performs in his academic subjects. In other words, what the other authors are telling us is that for two people, both with the same mental capacity, the one with the higher physical ability will perform better in the classroom.

Another thing that has been brought out by this review is the fact that most of the PAE items have good reliability. As long as prudence is exercised in selecting the test items, reliability should never present a problem.

#### B. Areas Requiring Further Attention

In addition to those things suggested above, several problem areas need further investigation.

The philosophical problem of whether or not the PAE should contain "non-practiceable" test items is a question which needs to be settled once and for all. It appears to be somewhat ludicrous to keep the test items veiled in secrecy when the candidate receives his PAE card in advance of the test and he also has the test items listed in his catalogue. If this restriction could be removed from the test, an immense amount of redundancy and confusion could be eliminated. Moreover, if each candidate not only received advanced notification of the test items but also received encouragement to practice the items, two benefits would occur. First, the reliability of the test would increase; and second, we would effect a higher level of fitness in our incoming class.

Another area requiring attention is the relationship between PAE performance and upper class physical education success. Nearly all of the studies relating these two variables have used only the fourth class.

One final note: if the PAE is ever to have better validity, reliability, and objectivity, additional research is absolutely essential. New test items which require little or no equipment and which can be administered in a hallway or in a doctor's office would revolutionize the PAE.

We need to keep looking.

[Table 8]

Correlations Between PAE Composite and Fourth Class  
Physical Education Grade

<u>STUDY</u>	<u>CLASS</u>	<u>N</u>	<u>4°PE</u>
8	59	--	.71*
8	60	--	.74*
8	61	--	.52 to .64*
8, 20, 24, 67	63	35	.51
24, 30	64	577	.54
49	64	118	.61
24, 52	65	667	.47
58	65	639	.46
62	71	759 to 1015	.38

\*These scores are spuriously high as PAE performance was included as part of physical education grade.

[Table 9]

Correlations Between PAE Composite and Individual  
Subject Fourth Class Physical Education Grade

<u>STUDY</u>	<u>CLASS</u>	<u>N</u>	<u>BX</u>	<u>GY</u>	<u>SW</u>	<u>WR</u>
15	68	898	.29	.29	.13	.21
45	71	714	(Multiple Correlations Only)			
49	64	118	.50	.48	.24	.38
58	65	639	.36	.42	.16	.27
62	63	759 to 1015	.29	.41	.11	.30

[Table 10]

Correlations Between Individual PAE Test Items and  
Fourth Class Physical Education Grade

<u>STUDY</u>	<u>CLASS</u>	<u>N</u>	<u>PAE ITEMS</u>	<u>PE</u>	<u>BX</u>	<u>GY</u>	<u>SW</u>	<u>WR</u>
20 & 49	64	118	MBP	.44	.44	.32	.21	.20
			Chins	.48	.07	.57	.32	.28
			HR	-.34	-.36	-.19	-.11	-.18
			VJ	.31	.31	.21	.01	.32
			300SR	-.43	-.40	-.30	-.18	-.24
58	65	639	MBP	.26	.31	.11	.07	.22
			C	.39	.13	.49	.17	.17
			HR	-.34	-.27	-.30	-.13	-.18
			VJ	.23	.19	.26	.07	.10
			300	-.32	-.28	-.25	-.08	-.21
			Mod BKB	.20				
			Throw					
67	63	85	PU	.48				
			HR	-.37				
			HSJ	.20				
			250	-.40				
52	65	160-174	MBP	.30 to .38				
			C	.34 to .39				
			HR	-.42 to -.46				
			VJ	.24 to .34				
			300SR	-.25 to -.31				
			BKB Pass	-.28				
			PU	.35				
			3BJS	.36				
			400SR	-.34				

[Table 11]

Correlations Between PAE and Leadership

<u>STUDY</u>	<u>CLASS</u>	<u>N</u>	<u>PAE TEST ITEM</u>	<u>Correlation W/Leadership</u>
56	59	--	Mod BKBT	.20
			Pull-Ups	.13
			HR	.30
			HSJ	.21
			250SR	.26
8	60	--	Composite	.25
	61	--	Composite	.29
30	64	577	Composite	.28
48	62-64	1973	Composite	.26 (.19 to .24 for 1st Classmen)
62	71	759-1015	Composite	.29
42	59	--	Composite	.32
	60	--	Composite	.25
	61	--	Composite	.29
	62	--	Composite	.18
	63	--	Composite	.22
	64	--	Composite	.28
	65	--	Composite	.25
	66	--	Composite	--
	67	--	Composite	.30



[Table 12]

## Test-Item Reliabilities

<u>STUDY</u>	<u>CLASS</u>	<u>N</u>	<u>TEST ITEM</u>	<u>RELIABILITY</u>
46	73	200	PU	.95
			HSJ	.93 to .94
			ZZR	.86 to .93
			MET	.94
			SU	.86 to .91
			300SR	.88 to .89
			Composite	.75 to .95
38	Prep Sch	85	Dips	.88
			RBJ	.81
			SMBT	.85
			DCT	.77
			SMBP	.87
			180BSR	.43
51	65	130 to 150	BKB Pass	.58
			Pull-Ups	.84
			3BJ	.89
			400SR	.55
			MBP	.88
			Chins	.90
			HR	.77
			VJ	.77
			300SR	.71

[Table 13]

Intercorrelations Between PAE Test Items

STUDY	V <sub>1</sub>	V <sub>2</sub>	r	STUDY	V <sub>1</sub>	V <sub>2</sub>	r
38	Dips	Pull-ups	.76	65	Grip Str	MBT	.40
	SMBT	MBP	.68		Grip Str	VJ	.32
	RBJ	SBJ	.62		MBT	HR	-.46
	MBPush	MBP	.61		MBT	300SR	-.52
	RBJ	HSJ	.57		Chins	VJ	.44
	DCT	HR	.56		HR	VJ	-.38
	180BSR	300SR	.51		HR	300SR	.65
	DCT	300SR	.50		VJ	300SR	.41
	DCT	HSJ	-.48	67	HR	250SR	.59
46	PAE	PFT	.55 to .62		HSJ	250SR	-.36
	PAE	1.5MR	-.10 to -.20		Mod BKBT	HR	-.38
	ZZR	HSJ	-.49	56	Mod BKBT	HR	-.36
	ZZR	300SR	.60		HSJ	HR	-.48
	WT	MBT	.66		250SR	HR	.68
	BSA	MBT	.62				
	HT	MBT	.42				
	BSA	Pull-ups	-.37				
51	WT	3BJ	.36				
	WT	MBP	.59				
	WT	Chins	-.32				
50	ZZR	90BSR	.71				
	HR	90BSR	.78				
	HR	ZZR	.79				
	VJ	SBJ	.74				
	SBJ	3BJ	.84				
	VJ	3BJ	.73				

The following, final section of the report by Harger and Keating (1973), summarizes the research-oriented view of the PAE from the early 1970s.

The total picture of the PAE leaves the impression that the early work of Appleton, McClothlin, Stillman and Kobes certainly presented an accurate assessment of the value of the PAE as a selection instrument. Based on the ground rules under which they were working the position was definitely sound. The leadership prediction data and increased attrition rates of low PAE performers reinforce their commitment to a physical aptitude index. Likewise, the unsuccessful attempts to streamline the test for financial reasons have borne out their insistence on a reliably administered, well standardized evaluation.

The future direction of candidate selection procedures appears stable, although the retrenchment process following the Viet Nam war and the present volatile mood of the nation certainly makes change a possibility. However, unless there is a drastic change in the Air Force Academy's mission, the need for physical fitness is an integral part of the whole man concept. When selecting cadets, we are dealing with young men's lives, their hopes and ambitions. A fair process is essential! We must be careful not to prostitute this procedure based on a need for cost effectiveness. General Clark, in discussing the challenge of leadership (62), quotes Admiral Rickover's comments to Congress in 1967. He said, "Human life is not 'quantifiable' in a cost effectiveness study, and therefore cannot be considered."

The immediate state of candidate selection requires a physical aptitude index and thus, in the interest of all candidates, it must be valid. The majority of the research reviewed in this study has dictated that a valid PAE is based on reliable and standardized administration. The high school mailout test was an abysmal failure in this regard. The future plans of the Air Force do contain limited use of Liaison Officers or test directors. Any wide expansion of this program would require thorough training programs for all personnel involved. The West Point experience with this method has been successful and therefore it appears to be a means of maintaining a valid PAE with some cost decrease.

Perhaps the major area of investigation now needed to further support the PAE's existence is a more sophisticated analysis of its relationship to leadership and overall cadet success. There is no doubt that it predicts which cadets will have physical trouble during BCT or which cadets will be low performers in physical education. However, although several studies have shown the

PAE to be one of the best predictors of leadership, this relationship is not high. The problem of predicting leadership is one which is being attempted in many fields, but, as of now, success with the PAE is limited. Thus, with the initial indications that the PAE is applicable in this area, it is essential that its value be pursued extensively.

An article in a recent educational journal exclaims, "To be able to predict leadership qualities in other people, then, is central to the functioning of all aspects of society." (66) Since the military is a microcosm of our entire society then the comments of Janowitz are particularly germane here. (65) He said, "After forty years of research and development of military personnel selection practices, it is now abundantly clear that there is no satisfactory and reliable technique for locating personnel with leadership potentials." (11) The impact of these two statements on the necessity of continued PAE leadership research is readily apparent.

The future trend of Basic Cadet Training could predicate changes in the PAE. Specifically, if USAFA were to move in the direction of the Naval Academy's approach, the necessity for the PAE would be diminished since physical fitness is not a major tenet in their program. However, if attempts to relate PAE to cadet success show positive results, then a PAE would be desirable on this basis alone.

In summary, the review supports the need for a valid PAE, and the present Physical Education Department position is one of military control. The suggested uses of Liaison Officers and Air National Guard sites is being pursued. Elimination of the PAE seems unlikely unless there is a drastic revision of the Air Force Academy's mission or philosophy of cadet development. The imminent need for research concerning the PAE involves its value in predicting cadet success.

Shadduck and Miller, 1979-81

During the period, 1979-81, the Admissions Liaison Office supported, through its Ready Reserve program, research concerning physical preparation for the PAE by candidates. Progress reports were made to the Admissions Liaison Office (Shadduck, 1979; Miller and Shadduck, 1980). These are summarized, and the final results of the project are reported here.

The objective of this investigation was to determine whether participation by USAFA applicants in a one-month long, semi-structured exercise program would enhance their performance in the PAE. The need for the investigation was identified by Col A. H. Parks, Liaison Officer Coordinator, Los Angeles, California (assigned to the Admissions Liaison Office, USAFA), in 1978. Parks pointed out that the advice to applicants set forth in the Academy catalog, to

prepare for the PAE, gave no guidance except to "engage in vigorous physical activity" and to practice the (illustrated) test items. In the investigation reported here, various physical activities and the practice of two test items were assessed with regard to their preparatory value for the PAE in this investigation.

In addition to the assessment of the preparatory value of various exercises, the investigation allowed assessments of (a) the practicality of implementing an applicant/candidate/appointee physical preparation program in the field and (b) the effectiveness of only one month's self-initiated physical conditioning on physical test performance. The results of the investigation, then, may be generalizable to the problem of assuring physical fitness in appointees when they arrive at USAFA to begin Basic Cadet Training.

Methods--The investigation was performed in three phases, during the 1978-79, 1979-80, and 1980-81 admissions cycles (October through April) at the Los Angeles PAE test center. During the first phase, intercorrelations of test scores among the four PAE tasks were examined for 74 male applicants and a kinesiological summary of the four PAE events was prepared. The results of the first phase were reported by Shadduck (1979). During the second phase, a research protocol was prepared, submitted to the USAF Surgeon General, and approved with slight revisions (SGO file no. R-79-11). Thirteen male applicants took part in phase 2. The results were reported by Miller and Shadduck (1980). During the third phase, data were collected from 24 male applicants, bringing the subject sample size up to 37. Participants were solicited, by letter, from those applicants scheduled by the USAFA Admissions Office to take the PAE. Volunteers for the investigation signed consent forms, prepared in accord with AFR 169-3. After participation in their first PAE, the participants were briefed about the nature of the investigation and about the preparation exercises and warm-ups. They received an 11- x 17-inch form, printed on heavy paper stock, on which to record daily exercise repetitions for approximately one month. Instructions and cautions for the conduct of each exercise were printed on the back of the form. The following exercises were examined:

Arm curls--Hold dumbbells with palms of hands facing away from body. Increase weight, as required, to allow at least 8, but no more than 12 repetitions in each series.

Modified pull-up--PAE-type pull-up, palms facing away from body, starting with feet on floor.

Low bar pull-up--Starting with feet on floor and elbows partially flexed.

Difficult pull-up--PAE-type pull-up with weights attached to waist or ankles.

Pull-downs--Pull down bar attached to weights via pulley (required gymnasium equipment).

Skipping rope--Standard form, with rope passing under feet at alternate jumps.

Advanced skipping--Rope passes under feet at each jump.

Leg presses--Leg lift bar attached to table and weights (required gymnasium equipment)

Bicycling (miles per day)--actual or on gymnasium equipment.

Handball court throw--throw from kneeling position against outdoor handball court wall (or other wall), gradually increasing distance.

Partner catch--As above, but with partner rather than wall.

Medicine ball throw--PAE-type basketball throw performed with heavier ball (usually available in a gymnasium).

Softball catch--normal game of catch, with softball, using greatest distance practical.

Deceleration turn--practice decelerating from fast run and reversing direction.

Shuttle run--practice the PAE task.

The data collected from the 37 participants were examined in several ways. Comparisons of first to second PAE performances were made using the paired t-test. For improved PAE performance, median splits of participants using a given exercise, using first PAE performance on the relevant event as the split criterion, were used to allow us to examine the effects of prior physical competence on the relationships between improvements, and numbers of exercise repetitions. The relationships of exercise repetitions (for the subgroup of participants that reported using each exercise) to PAE event score changes were examined using Pearson product-moment correlation values, as were the relationships of participant height and weight to PAE performances. Height and/or weight effects were to be partialled out of the former relationships in those cases where the latter relationships showed statistically non-zero interactions between height and/or weight and PAE event performance.

Results--Overall, the 37 participants displayed a 20% increase in pull-up performance and a 4% increase in basketball throw performance from the first to the second PAE. Long jump and shuttle run performances did not change. The event performance values for the first and second PAEs are shown in Table 14. (These data do not allow a consideration of the effects of height, weight, or prior physical competence.) The test-retest reliability of these scores (by Pearson r) was as follows: pull-ups, .864; long-jump, .864; basketball throw, .901; and shuttle-run time, .872.

TABLE 14. FIRST AND SECOND PAE PERFORMANCE SCORES FOR 37 MALE USAFA APPLICANTS

Event	Mean $\pm$ S.D.		t
	First PAE	Second PAE	
Pull-ups (number)	8.8 $\pm$ 3.4	10.5 $\pm$ 4.0	5.33*
Long-jump (feet)	7.55 $\pm$ .50	7.62 $\pm$ .54	1.39
Basketball throw (feet)	62.8 $\pm$ 10.4	65.4 $\pm$ 9.0	3.51*
Shuttle run (sec)	60.48 $\pm$ 2.37	60.33 $\pm$ 2.15	-.78

\*  $p < .01$  (paired t-test, one-tail)

Each participant did not use every suggested exercise, thus subgroups of participants ( $n < 37$ ) were considered when exercise repetitions were compared to changes in PAE performance. Table 15 shows the numbers of participants who reported repetitions of exercises and the numbers of repetitions.

TABLE 15. REPORTED NUMBERS OF REPETITIONS OF EXERCISES

Exercise	N	Minimum	Mean	Maximum
Arm curls	28	41	341	1090
Modified pull-up	25	5	103	256
Low-bar pull-up	23	5	122	320
Difficult pull-up	24	12	115	296
Pull-downs	12	40	246	666
Skipping rope	26	10	1687	5411
Advanced skipping	14	50	1263	3284
Leg presses	16	45	301	1081
Bicycling (miles)	12	8	66	128
Handball court throw	18	30	417	1355
Partner catch	13	4	291	830
Medicine ball throw		(none reported)		
Softball catch	11	8	259	769
Deceleration turn	24	2	85	293
Shuttle run exercise	27	1	11	42

We noted at the end of phase two of this project that no strong relationships between exercise repetitions and PAE performance change were apparent. We surmised that too few repetitions were being completed to cause a training effect. The average numbers of exercise repetitions were calculated for phase two ( $n = 13$ ), rounded off, and suggested as minimums for those subjects participating in phase three ( $n = 24$ ). (The minimums were printed on the form supplied to the subjects.) To examine the effect of this strategy, the ratios of mean repetitions to minimums were calculated. These are shown in Table 16. Repetition means exceeded minimums in six of eight cases for arm exercises and in two of five cases, with one tie, for leg exercises.

TABLE 16. REPETITION MINIMUMS AND RATIOS OF MEAN REPORTED REPETITIONS TO GOALS

Exercise	Repetition Minimum	Mean ÷ Minimum
Arm curls	300	1.14
Modified pull-up	100	1.03
Low-bar pull-up	100	1.22
Difficult pull-up	140	.82
Pull-downs	275	.89
Skipping rope	1600	1.05
Advanced rope skipping	1800	.70
Leg presses	300	1.00
Bicycling	-	-
Handball court throw	330	1.26
Partner catch	250	1.16
Medicine ball throw	-	-
Softball catch	200	1.30
Deceleration turn	70	1.21
Shuttle run exercise	14	.79

The relationships among the improved PAE events, both requiring arm strength, and the arm exercises are shown in Table 17. There were no significant differences in correlation (t test) within the median-split subgroups (split with regard to first PAE performance on the respective event), so only the values for the full subgroups are shown here. Additionally, there were no significant correlation differences with the leg-associated median-split subgroups (Table 18).

TABLE 17. RELATIONSHIPS BETWEEN ARM EXERCISE REPETITIONS AND PAE EVENT PERFORMANCE CHANGES

<u>Exercise (n)</u>	<u>Pull-ups</u>	<u>Pearson r</u>
		<u>Basketball throw</u>
Arm curls (28)	-.080	-.347
Modified pull-ups (25)	-.014	.008
Low-bar pull-ups (23)	.518*	.269
Difficult pull-ups (24)	.326	-.002
Pull-downs (12)	.233	.103
Handball court throw (18)	.258	.277
Partner catch (13)	-.102	-.319
Softball catch (11)	.244	.537

\*p < .05

TABLE 18. RELATIONSHIPS BETWEEN LEG EXERCISE REPETITIONS AND PAE EVENT PERFORMANCE CHANGES

<u>Exercise (n)</u>	<u>Long-jump</u>	<u>Pearson r</u>
		<u>Shuttle run time</u>
Skipping rope (26)	.263	.124
Advanced skipping (14)	.398	.439
Leg presses (16)	.232	-.378
Bicycling (12)	-.333	.080
Deceleration turn (24)	-.068	-.128
Shuttle run exercise (27)	-.027	-.325



The 37 subjects ranged in weight from 122 to 207.5 lb (mean, 154.5 lb), and in height from 64 to 74 in. (mean, 70.2 in.). We examined the effects of weight on PAE pull-up performance. (Weight changes from the first to second PAEs did not appear to affect any of the results reported in this paper.) We found a unique effect of body weight (height held constant) on pull-up performance (partial  $r = -.402$ , Table 19).

TABLE 19. RELATIONSHIPS AMONG HEIGHT, WEIGHT, AND THE PERFORMANCE OF EVENTS AT THE FIRST PAE ( $n = 37$ )

	<u>Pull-ups</u>	<u>Long-jump</u>	<u>B.B. throw</u>	<u>Shuttle run time</u>
	<u>Pearson <math>r</math></u>			
Weight	-.496*	-.124	.434*	-.151
Height	-.317	.099	.180	-.101
( $r = .635$ )				
	<u>Partial <math>r</math></u>			
Weight	-.402*	-.243	.421*	-.113
Height	-.003	.232	-.137	-.007

\* $p < .05$

Intercorrelations among PAE pull-up performance improvement, exercise repetitions, and weight for the subgroups reporting the first five exercises listed in Table 17 were all insignificant, except for the relationship of low-bar pull-up repetitions to the 2.5-pull-up increase for that subgroup ( $r = .518$ ). The partialling of weight out of that relationship had virtually no effect (partial  $r = .521$ ), nor did the partialling-out of weight elevate any of the other four exercise-performance relationships to reliable levels.

Discussion--With the exception of one event, the 37 USAFA applicants appeared to improve their performance little from one PAE to the next, using the numbers of exercise repetitions they reported. The exception was the 20% improvement in pull-up performance. A consideration of the results, reported above, sheds some light on this situation.

The relative usefulness of an exercise may be indexed by the numbers of persons attempting it. Arm curl/pull-up, rope skipping, and running exercises were attempted the most (Table 15). Of these exercises, low-bar pull-ups, the deceleration turn exercise, and arm curls reflected the greatest mean-repetition-to-minimum ratios, in diminishing order (Table 16). These two sets of information allow the suggestion that low-bar pull-ups should have had a substantial training effect, compared to most of the other exercises examined: Many subjects tried the low-bar pull-up, and they generally exceeded a not-completely-arbitrary repetition minimum in doing so.

Often, persons who are more physically fit improve relatively less in performance after a given amount of practice than do those who are less fit. We examined the effects of prior physical competence on PAE-to-PAE improvement by splitting the exercise subgroups around the first-PAE event performance median score. We found that correlations between repetitions and PAE performance changes did not differ as a function of being above or below the median performance level for the respective event at the first PAE. The failure to find this effect may be due to small sample sizes and high intersubject variabilities. Alternatively, the numbers of repetitions may have been too low to produce the effect. This latter suggestion is supported by the lack of general PAE performance improvement noted.

The search for clues that would reveal reasons for changes in PAE performance relied heavily on showing correlations between changes and exercise repetitions. While "correlation does not show causation," it was felt that the study design would allow limited statements of causation to be made. The single reliable relationship observed (that between low-bar pull-ups and PAE pull-up performance improvement, Table 17) comes as no surprise in view of the earlier discussion concerning exercise usefulness. The failure to find other reliable relationships supports, again, the suggestion that too few repetitions were accomplished to provide a training effect.

The results discussed here reveal some information about the process by which young male adults may prepare for tests on the events examined here. Most obvious, about 122 low-bar pull-ups may result in a 2.5-pull-up improvement in pull-up performance. This statement must be heavily tempered by the fact that this exercise accounted for only 27% of the variance in PAE pull-up performance change; other factors, unaccounted for in this investigation, provided the other 73% variance. However, the low-bar pull-up is probably a beneficial training exercise.

More generally, we concluded that too few repetitions were performed to cause a training effect. This may have been due to inadequate effort on the part of the subjects. This suggestion is supported by the relatively low repetitions-to-minimums ratios observed. Alternatively, too little time (ca. one month) may have been allowed for training effects to take place at the reported repetition rates. The exercises, selected with regard to a kinesiology based review of the natures of the PAE events (Shadduck, 1979), were probably capable of inducing appropriate training effects, given adequate time and repetitions. Perhaps sequentially graded minimums, spread out over a period of time greater than one month, would be appropriate for future investigations.

The investigation allowed the development of a reasonably practical way of assisting USAFA applicants/candidates/appointees with their physical preparation for entry into USAFA and Basic Cadet Training. A briefing, the distribution of printed guidance as to the types of warm-ups and exercises, and the recommendation of numbers of exercise repetitions may be useful techniques to use in preparing future students for the physical rigors of Cadet life.

The investigation also pointed out the fact that as little as one-month's physical preparation can make a difference in physical competence on some tests. Greater time should be used in physical preparation for USAFA, but this result indicates that some positive effects of physical training for USAFA should be measurable after one month of effort. This idea may be encouraging to applicants who need extensive physical preparation.

#### PHYSICAL DEMANDS OF CADET AND OFFICER LIFE

Few objective data describe the physical demands of USAFA Cadet or USAF active duty officer life styles. This is unfortunate, since the knowledge of such demands would allow a quantitative rather than qualitative approach to the specification of candidate, cadet, and officer physical fitness testing procedures. A recent assessment of USAFA physical demands is reported in this section.

##### Estimated Energy Demand of Basic Cadet Training (BCT) Lt Kory Cornum December 1981

The caloric expenditure required to complete BCT is estimated in this discussion for an average male Basic Cadet: 71.8 kg (158 lb), 178 cm (70 in), 18 years of age. Published energy expenditure tables for various types of work were used to provide individual task caloric demand estimates. The tasks were those listed on the BCT master schedule.

Basic Cadet Training is a 42-day (1008-h) program. For the purpose of this discussion, BCT was divided into sleeping, inactive, and active periods, and energy expenditures were calculated for each period. Specific information about running, the obstacle course, and the Valley Sweepstakes is also presented.

The metabolic rate during sleep is approximately 1 kcal/min. The BCT schedule allows 8 h/day for sleep, and an estimate of 480 kcal/day was accepted for this portion of BCT.

The inactive portion of BCT accounts for 395 h. It is composed primarily of sedentary tasks such as lectures and meals. A metabolic rate of 3 kcal/min was estimated for this period, resulting in an average expenditure of 1693 kcal/day. A small portion of the inactive period is spent running to and from activities. The additional energy expenditure for this running is discussed below.

Active awake time was broken down into individual activities and the number of hours spent at each activity, as listed on the BCT master schedule. The activities are listed in Table 20, grouped as extreme (greater than 15 kcal/min), heavy (10-15 kcal/min), moderate (5-10 kcal/min), and light (less than 5 kcal/min) tasks. Active time accounts for 277 h of BCT, of which 18 h are spent in extreme work, 62 h in heavy work, 153 h in moderate work, and 44 h in light work. The 144,000 kcal active-time total represents an average 3,429 kcal/day energy expenditure.

TABLE 20. CALORIC DEMAND OF TASKS DURING BCT ACTIVE PERIODS

<u>Activity</u>	<u>Group</u>	<u>Kcal/min</u>	<u>Total hours</u>	<u>Kcal required</u>
PFT	Ex	20	1	1200
Obstacle Course	Ex	20	6	7200
Assault Course	Ex	18	8	8640
Valley Sweepstakes	Ex	15	3	2700
Physical Conditioning	H	10	15	9000
Sports/Intramural	H	13	22	17160
Leadership Reaction Course	H	10	8	3840
Element Competition	H	12	4	2880
Confidence Course	H	10	4	1920
Field Day	H	13	8	6240
Swimming	H	11	1	660
Drill	M	10	37	22200
Squadron Training	M	6	70	25200
Valley Teardown	M	7	2	840
Valley Set-up	M	7	5	2100
Road March	M	8	5	2400
Recondo	M	9	10	5400
Moving into Squadrons	M	7	4	1680
Marching to Meal	M	20	10	12000
In processing	L	5	8	2400
Appointments	L	4	10	2400
First Aid	L	5	5	1500
IRI	L	3	3	540
SAMI	L	3	3	540
Parade	L	4	4	960
Weapons	L	5	8	2400

TOTAL 144,000 kcal  
 ÷ 42 days = 3429  
 kcal/day

Running--Planned runs and the distances run to and from all formations, classes, and other activities during BCT were summed, revealing that Basics run 116 miles during the active and inactive periods of the 42 days. The mean daily distance is 2.8 miles, ranging from 0.2 to 7.0 miles, with a standard deviation of 1.8 miles (i.e., two-thirds of the days require 1.0 to 4.6 miles of running, while a couple of days may require as little as 0.2 miles or as much as 7.0 miles). The values suggested that running is an important part of BCT. Assuming 300 kcal to be expended during a 2.8-mile run, an average of 9% of each day's energy expenditure is devoted to running.

The proportion of distances run during the inactive periods was 31.2 miles for the 42 days, averaging 0.7 mi/day, or 80 kcal/day. This expenditure must be added to the sleeping, inactive, and active values presented above. The remaining 220 kcal/day expenditure is included in the active state calculations.

Total Daily Expenditure--The sum of the values presented is shown in Table 21. The average energy demand during BCT is 5682 kcal/day. This value is not corrected for the effect of altitude on oxygen uptake. At 2100m (7,000 ft), average maximum aerobic capacity is diminished to 80% of average sea level values. The correction,  $5682 \div .80$ , suggests that 7102 kcal/day may be required on an average BCT day. The cadet nutritional allowance is 5800 kcal/day\*. Basic Cadets who are within body weight tolerances should probably be allowed a greater caloric input during BCT.

TABLE 21. SUM OF ESTIMATED DAILY AVERAGE ENERGY EXPENDITURE RATES

BCT period	Hours	Energy Expenditure Rate (kcal/day)
Sleep	336	480
Inactive	395	1693
Running	-	80
Active	277	3429
TOTALS 1008 h		5682 kcal/day

The Obstacle Course--The O-Course is an event of peak physical demand during BCT. It is primarily an anaerobic task; its obstacles are laid out over a course that covers a distance of about one-half mile. There are 15 obstacles, of which 7 require bicep use, 2 require triceps, and 9 require leg strength. Although all of the obstacles test coordination and agility, three were designed with these primarily in mind: over-under log, log balance, and zig-zag. Only three obstacles require that the body weight be entirely supported by the arms (two hanging, 1 pushing), and none of these require push-up-type or pull-up-type motions; the body weight is simply supported in a static state.

The Valley Sweepstakes--The Sweepstakes represents a peak aerobic physical demand on the Basic Cadet. It is a 4.5-mile cross-country run, performed in fatigues and combat boots carrying a 4.5 kg (10 lb) rifle.

\*Personal communication, USAFA/CWLH (D. Saito), 1981.

## CONCLUDING NOTES

This technical report is but a brief summary of readily available documents and data concerning physical fitness testing at USAFA. The text and the bibliography following these notes are meant to be used as a source document for the continuing development of USAFA physical fitness testing procedures.

A step has been taken toward updating USAFA-candidate physical fitness testing procedures (the "PAE"). The notes of the workshop at which that step was planned are appended (Appendix B).

As this report goes to press, increased efforts by the U.S. Air Force to improve the physical fitness and appearance of all active duty personnel are being publicized. The specific strength requirements of several USAF tasks are also being examined (Appendix C). Additionally, a new USAF Advisory Council on physical fitness has met for the first time, under the sponsorship of MPC/ASD. USAFA will, no doubt, lead the U.S. Air Force in applying the best available techniques to physical fitness testing, working in conjunction with the Council.

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This bibliography is split into four sections. The first section includes references from the original text of this Technical Report. The second through fourth sections are reproductions of the references from Walter (1970), Sampson (1971), and Harger and Keating (1973), respectively. Though some redundancy is introduced here, the reader will be able to trace numbered references in the text quoted from these papers by using these reproduced bibliographies.

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Reasons why you are conducting the clinic.

1. PAE is given to about 5,000 candidates at approximately 62 different Examining Centers.
2. About 8 to 16% of those candidates who score the least points are disqualified.
3. Of the remaining candidates, the score made on the PAE will either help or hinder their chances of selection as a cadet.
4. Since we all want only the best candidate as cadets and future officers, standardization in the administration of the PAE is very important. It is of vital importance that candidate John Jones on a given day can perform 5 pull-ups, run the shuttle-run in 62 seconds, and do 7 feet in the standing broad jump, he would receive these scores wherever he was tested that day ---- in Iowa, Alaska, Hawaii, Nebraska, et cetera. Faulty measurement, counting or time may allow a less qualified candidate to enter the Air Force Academy over a better qualified young man.
5. The mere fact that you administer the PAE consistently is not the answer. Not only must you administer it consistently, but you must administer each test item exactly as it is done at 62 other Centers. That is, the medicine ball must weigh exactly 6 pounds, extra motivation and coaching must not be given, etc.

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## APPENDIX A

### A NOTE ABOUT T-SCORE CONVERSIONS

The T-score scale is a linear transform of standard deviation units, also called z-scores, in which the mean of a normal distribution ( $z=0$ ) is set at  $T=50$ . Each standard deviation unit above and below the mean is represented by a T increment of 10. Thus,  $T=30$  is two standard deviations below the mean ( $z=-2.0$ ). With the aid of a table of z-scores, one can identify the proportion of a group that is cut-off below a given T-score criterion. For instance, using a criterion of  $T=30$ , 2.3% of the group will probably fall below the criterion. The proportions falling below the criterion in the range  $T=25$  to 45 (0.5 to 2 standard deviations below the mean) are shown in Table A-1.

TABLE A-1. T-SCORES, Z-SCORES, AND THE PROPORTION BELOW THE T-SCORE. (Note that T-score  $\times 10$  gives the Scholastic Aptitude Test (SAT) type of score used in calculating USAFA admissions composites.)

<u>T-score</u>	<u>Z-score</u>	<u>Percent below score</u>
45	-.5	30.85
44	-.6	27.43
43	-.7	24.20
42	-.8	21.19
41	-.9	18.41
40	-1.0	15.87
39	-1.1	13.57
38	-1.2	11.51
37	-1.3	9.68
36	-1.4	8.08
35	-1.5	6.68
34	-1.6	5.48
33	-1.7	4.46
32	-1.8	3.59
31	-1.9	2.87
30	-2.0	2.28
29	-2.1	1.79
28	-2.2	1.39
27	-2.3	1.07
26	-2.4	.82
25	-2.5	.62

## APPENDIX B

### REPORT OF WORKSHOP ON USAFA PHYSICAL FITNESS TESTING

February 1982

J. C. Miller

During the summer and fall of 1981, a number of doubts about the adequacy of Cadet and candidate physical fitness testing were identified by the USAF Academy Directorates of Admissions (RR) and Athletics (AH). A workshop, attended by academic and Air Force specialists in physical fitness and admissions requirements, was convened at USAFA, 17-18 February 1982, under the sponsorship of RR and AH. The participants considered the adequacies of the current Physical Aptitude Examination (PAE) for candidates and the Physical Fitness Test (PFT) for Cadets, discussed the demands of Cadet and active-duty officer physical activities, and drafted guidelines for future USAFA physical fitness testing. The workshop discussions are summarized in this report, and a work plan for implementing the guidelines is presented.

The workshop participants are listed in Attachment 1 to this report. The two academic specialists who attended are highly qualified to advise USAFA on physical fitness tests. Dr Steven M. Horvath is recognized as one of the world's leading authorities on the effects of exercise, heat, cold, altitude, air pollution, and aging on human function. In 1977, an international symposium, "Environmental Stress: Individual Human Adaptations," was held in honor of Dr Horvath. In the preface to the book which documents that symposium, it was noted that Dr Horvath, "throughout his long and productive career has made and continues to make extensive contributions to our knowledge of man's adaptability to environmental stress." Dr James E. Wilkerson, recognized for his outstanding research contributions in physical fitness and muscle biochemistry, is a member of the U.S. Olympic Track and Field Development Committee and serves as the Chairman of its Scientific Sub-committee.

The Director of the Office of Admissions and USAFA Registrar, Col Warren L. Simmons, participated in the workshop. His office was also represented by Capt William J. Strickland, from the Directorate of Institutional Research (RRE). Capt Strickland holds a doctorate in Psychological Test and Evaluation, and is responsible for investigating, among other things, relationships among physical fitness, indices of success at USAFA, and Cadet retention. Capt Robert D. Shadduck represented the Admissions Liaison Office (RRV). Capt Shadduck is one of many hundreds of USAF Reserve Admissions Liaison Officers, who represent USAFA and AFROTC in the nation's high schools and communities. He also directs the Los Angeles, CA PAE Testing Center and has directed an investigation of the effects of physical training on PAE performance.

The Head of the Physical Education Division (AHP), Col Richelieu N. Johnson, participated in the workshop, as did two members of his staff. Maj P. Richard Elliott and Capt Richard W. Côté hold doctorates in Physiology and bear the ultimate burden at USAFA of assuring the technical adequacy of the PAE and PFT.

Finally, the USAF School of Aerospace Medicine was represented by Dr Loren G. Myhre. Dr Myhre has performed many investigations that involve measuring the fitness of USAF personnel. He is presently assisting the administrative office\* responsible for the testing of the physical fitness of all USAF personnel in an effort to bring state-of-the art techniques to such assessments. The workshop was convened and chaired by Dr James C. Miller, a research physiologist at USAFSAM and a USAF Reserve Liaison Officer Coordinator for RRV.

Col Simmons, the Director of Admissions, in his opening remarks, expressed several concerns about physical fitness testing of candidates. First, he pointed out the high failure rate on the PFT among appointees beginning Basic Cadet Training (BCT). It would be preferable if appointees were physically prepared, through training or selection, to pass this first PFT. There is anecdotal evidence suggesting that a greater likelihood of appointee retention in BCT is associated with greater physical strength and endurance. Col Simmons noted the need to consider the fitness needs of officers and Cadets in designing fitness testing techniques and criteria for candidates. The need for fairness in determining a whole-person fitness score was mentioned with regard to "equal scores for equal efforts" when male and female candidates are compared. He noted the need for the coordination of changes in physical fitness testing procedures at USAFA with West Point and Annapolis. Finally, after briefing the meeting participants on the role of the PAE in the admissions process, he pointed out that heights and weights of candidates have not been used as covariates in the consideration of PAE scores, and pointed out the need for the participants to consider carefully the setting of performance minima for upper body strength and for running endurance.

Col Johnson's remarks outlined AH's needs with respect to physical fitness testing. He pointed out that USAF active-duty requirements for physical fitness take precedence over USAFA, but that AH needs a test that will identify candidates who can withstand physical stress and who can present a good physical image. Although the average level of physical fitness of USAFA appointees, when they arrive for BCT, is at about the 70th percentile of the national distribution of high school students, 2 to 3 percent of the Basic Cadets cannot pass the PFT at the end of BCT. Some of these are at the top of their allowed weight range, some are female. Last year, two Cadets were disenrolled for repeated failures of the PFT. USAFA should be able to screen out such individuals prior to appointment to USAFA, and must have a defensible, state-of-the-art fitness test upon which to base disenrollment decisions, should the occasion arise. Col Johnson pointed out that the Cadets not only must undergo BCT upon arrival at USAFA, but then continue a vigorous sports and physical education program during their Cadet years. He underscored the need for a candidate physical fitness test that predicts at least physical success at USAFA and screens out applicants who cannot handle the physical stresses at USAFA. The test must be reliable, and ease of administration is needed. He expressed interest in the inclusion of estimates of body composition in the applicant test.

The discussion that followed the opening remarks by Cols Simmons and Johnson was initiated by Dr Horvath, who asked if the physical demands of active duty officers had been documented. Drs Myhre and Miller agreed that

\*Appearance and Standards, (AFMPC/ASD), Randolph AFB TX 78148, (512) 652-3415

such documentation did not exist, but that a few USAF-pilot-oriented programs were currently under way at USAFSAM and AFAMRL that might shed some light on such demands. Maj Elliott cited a survey of USAFA graduates which indicated that, five years after graduation, they continued to accumulate an average of 60 Aerobics points per week and had gained an average of five pounds. Thus, many graduates apparently try to maintain fitness after graduation. Dr Wilkerson suggested a testable hypothesis based upon the collection of USAFA-graduate morbidity and mortality data: if the USAFA physical education program does change Cadet life-styles with regard to fitness maintenance, then such data might correlate with the Cadets' last physical fitness scores before graduation; if not, then such data might correlate with the Cadets' pre-BCT physical fitness scores instead. Dr Wilkerson also pointed out the usefulness of longitudinal (life-long) body composition data on graduates in order to test this hypothesis. Finally, Col Simmons pointed out that the meeting participants need not be overly concerned with the impact of active-duty-officer physical fitness needs, since it is appropriate that USAFA take the lead for USAF in helping to determine such matters.

Capt Shadduck presented a briefing on the administration of the PAE. Much of the material he presented is available in the PAE Test Director's Handbook, published by RR, and will not be repeated here. However, several points of emphasis and some data are appropriate for this report. First, the difficulty of maintaining floor markings, or repeatedly marking the floor, for the basketball throw and the standing long jump, in the field (AFB or high school gymnasiums) was pointed out. Second, the control of the PAE (i.e., instructions are read word-for-word and no additional instructions are given, the four test items are given in the same order to all candidates, etc) was emphasized. However, in discussion, Col Simmons noted that the elapsed time between test items in the PAE was not held constant as it is in the PFT (i.e., when 30 candidates show up for one of the eight PAE tests given each year at the 150 PAE test sites, there is a longer elapsed time between test items than when only 2 candidates show up). Dr Horvath noted that audio-taped or video-taped instructions would reduce test-site differences in the presentation of PAE information to candidates. Finally, Capt Shadduck presented data concerning Los Angeles test-site male candidates first-administration\* performance on each of the PAE test items. These data are included as Tables B-1 through B-4, and agree with the RR data presented in Figure 1 in the body of this Technical Report.

Dr Myhre summarized his observations of physical fitness and tests thereof in the active duty Air Force. He has seen or heard of the 1 1/2-mile run being administered poorly in the field: self-counted numbers of laps may not be accurately reported by test participants, and excessive corner-cutting may take place when laps are run indoors on gymnasium floors. The 1 1/2-mile run suffers from a low frequency of administration: once per year. This results in useless and dangerous last-minute, instead of continuous, training by many USAF personnel. Finally, the standards for passing the 1 1/2-mile run or the 3-mile walk are set so low that very little aerobic power is required to pass these tests. Dr Myhre has measured aerobic power in enlisted personnel performing Rapid Runway Repair at Eglin AFB FL and recorded alarmingly low levels of fitness, e.g., a 17-year-old man with the fitness of a 70-year-old man. Dr Myhre will sample the aerobic power of active-duty personnel at Minot AFB ND

\*Some candidates returned for second PAEs on another test date.

TABLE B-1. USAF ACADEMY PAE MALE PULL-UP SUMMARY  
(LOS ANGELES TESTING CENTER, 1978-1981). NUMBER OF PULL-UPS.

CYCLE	N	MEAN	MODE	MEDIAN	RANGE	SD
78-79	74	9.6	11.0	9.9	1-23	4.3
79-80	69	9.6	10.0	9.6	0-18	4.2
80-81	86	10.1	10.0	9.9	2-18	3.8

TABLE B-2. USAF ACADEMY PAE MALE STANDING LONG JUMP SUMMARY  
(LOS ANGELES TESTING CENTER, 1978-1981). IN FEET.

CYCLE	N	MEAN	MODE	MEDIAN	RANGE	SD
78-79	74	7.88	8.0	8.0	6.40-9.20	.58
79-80	69	7.78	BI <sup>1</sup>	7.8	6.08-9.00	.57
80-81	86	7.70	BI	7.7	6.33-9.00	.54

TABLE B-3. USAF ACADEMY PAE MALE BASKETBALL THROW SUMMARY  
(LOS ANGELES TESTING CENTER, 1978-1981). IN FEET.

CYCLE	N	MEAN	MODE	MEDIAN	RANGE	SD
78-79	74	68.2	76.0	67.8	42-94	10.9
79-80	69	68.4	67.0	67.8	51-92	9.5
80-81	86	65.5	MULTI <sup>2</sup>	65.3	44-99	10.2

TABLE B-4. USAF ACADEMY PAE MALE 300-YD SHUTTLE RUN SUMMARY  
(LOS ANGELES TESTING CENTER, 1978-1981). IN SECONDS.

CYCLE	N	MEAN	MODE	MEDIAN	RANGE	SD
78-79	74	59.76	59.4	59.6	55.0-66.2	2.48
79-80	69	59.91	60.5	59.6	55.8-67.6	2.63
80-81	86	60.26	BI	59.6	55.5-70.8	2.80

<sup>1</sup>Bimodal

<sup>2</sup>Multimodal

and Carswell AFB TX this winter and spring. He is designing an adaptive sub-maximal protocol for the bicycle ergometer that will allow individuals with low aerobic power to at least complete the test, and suggests a criterion of 40 to 45 ml/min/kg oxygen uptake ( $\dot{V}O_2$ ) as a standard of aerobic fitness. Dr Horvath remarked that he had measured aerobic power in aluminum-smelter workers in Texas and found an average 30 ml/min/kg  $\dot{V}O_2$ . Many of these workers were obese. He also mentioned the ca. 10% error of the method in bicycle ergometry, but pointed out that it was the best field-deployable device available for the estimation of aerobic power. He and Dr Myhre agreed that the adjustment of  $\dot{V}O_2$  by body weight (ml/min\*kg) sharply separates obese individuals from non-obese, fit individuals.

Capt Coté described the new educational program constructed for the Morale, Welfare and Recreation administrators at the Manpower and Personnel Center.\* USAFA/AHPA is providing technical education in fitness training techniques and in cardiovascular disease for the MWR specialists who run Air Force gymnasiums around the world. Some of these specialists are involved in the administration of PAEs and USAF 1 1/2-mile-run/3-mile-walk tests. Dr Miller suggested that the educational program be handed-off to the School of Aerospace Medicine Education Division (USAFSAM/ED), and that the USAFSAM Physiological Training Officer (PTO) program be expanded to incorporate PTOs into the USAF-wide physical fitness training and testing community. Dr Horvath remarked that research performed by the Army at Ft Dix, concerning physical fitness, was one of the triggers for a Dept of Defense Symposium on physical fitness that was held at the Pentagon in the summer of 1980. The recommendations of our USAFA workshop, reported below, may be regarded as a part of the USAFA response to the call for enhanced physical fitness and enhanced physical fitness testing techniques heard at the DoD Symposium.

Some eight hours of discussion by the workshop participants followed the information presented above and resulted in the numbered conclusions and recommendations presented below. It should be noted that the workshop represented an application of a large amount of the highest-quality basic physiological research, much of which was supported over the years by the AF Office of Scientific Research (AFOSR). Additionally, many of the participants noted that the degree of consensus reached among themselves, regarding their conclusions and recommendations, was remarkable. This consensus may reflect the ubiquity among physiologists of the recognition of the need for the enhancement of physical fitness testing procedures in operational environments.

1. With respect to the relationship of the future course of USAFA physical fitness requirements and testing methods to USAF needs for officer physical fitness, the following conclusions were reached: (a) that USAF is in a state of transition as a result of the 1980 DoD Symposium recommendations; (b) that USAF (specifically, AFMPC/ASD) must be kept advised of USAFA

\*AFMPC/MWR, Randolph AFB TX 78148

advances; and (c) that USAFA should not hesitate to take the lead in prescribing physical fitness criteria. Dr Miller suggested that USAFA or USAFSAM might take the lead in introducing some form of executive fitness training to the Air Staff in view of these conclusions.

2. The objective of the workshop participants' recommendations was: to measure four characteristics of USAFA candidate physical fitness. If these characteristics are measured appropriately, they should provide far better than existing predictions of success in performing the Cadet PFT, the Cadet 1 1/2-mile run, physical education grades, and, perhaps, the Cadet Military Performance Average. A probable result of the pass-fail criteria suggested by the participants is the general enhancement of Cadet physical fitness, or at least a truncating of the low end of the fitness distribution of entering appointees.

3. The Cadet PFT will not be radically changed in the next several years. There are two reasons for this recommendation. First, enhanced Cadet PFT performance may serve as a rough measure of the degree to which the candidate physical fitness screening process will be improved by the implementation of the recommendations set forth here. Second, PFT performance by Cadets is reasonably predictive of success in physical education courses. USAFA/AH will allow the successful implementation of candidate testing changes to drive changes to the PFT, as appropriate. The least useful test items in the PFT, it was decided, are the standing long-jump and the 600-yd run.

4. The idea of "physical aptitude" testing of candidates was labelled inappropriate. In the 40 years since the development of the PAE, investigators have found that "physical aptitude" is highly task specific. That is, to identify an aptitude for swimming, one must test an individual's swimming skills rather than something more abstract, such as his kneeling basketball-throw distance. The participants agreed that the present PAE does not sufficiently discriminate physical aptitude nor physical fitness. Additionally, they agreed that USAFA should emphasize candidate physical fitness testing over candidate physical aptitude testing. Thus, the participants recommended an end to the "PAE" and a move toward state-of-the-art testing of the physical fitness of USAFA candidates.

5. An interim Candidate Physical Fitness Test (CPFT)\* was outlined. The use of the term "interim" here is meant to show that USAFA is committed to the use of state-of-the-art measurement techniques in testing muscular strength, coordination, aerobic power, and body composition, but that not all of the techniques are field deployable by USAFA at this time. More primitive techniques will be used temporarily, and will be replaced by state-of-the-art techniques as permitted by logistics, funding, training, normative data acquisition, and test procedure development. The measurements of the four fitness characteristics are discussed in the following subparagraphs.

\*The name of the test was left open for further consideration. Capt Cote pointed out the appropriateness of the name, Candidate Fitness Test (CFT), and it was agreed that the term "physical" causes some candidates to confuse the PAE with the medical examination administered by the Department of Defense Medical Evaluation and Review Board (DODMERB) for the several Academies. However, the "CPFT" designation was that used during the workshop.



a. Muscular Strength. Tests of the static and dynamic strengths of specific muscle groups, using strain gauge devices, should be developed. The strain gauge devices should be purchased, test procedures should be established, and testing officer training should be accomplished after the appropriate tests have been identified. The particular strength requirements of USAF may become more clear as a result of current investigations by AFAMRL. Cadet strength requirements need to be quantified. In the interim, more primitive measures of upper body strength, those of the PFT, will be used: pull-ups, push-ups, and sit-ups, administered in that order, using existing PFT guidelines.

An item of great interest to both RR and AH was the method of scoring these tests of strength. The participants recommended the following scoring guidelines. First, a candidate must have non-zero scores on all three test items. In other words, to pass the CPFT, a candidate must be able to do at least one pull-up, at least one push-up, and at least one sit-up. Second, a minimum combined score for the three test items should be established. Dr Wilkerson recommended, and the other participants concurred, that the sum of the 20th percentiles of the Cadet T-score distributions for the three test items be used as the candidate criterion. There are obvious discontinuities in the Cadet norms for each test item at the 20th percentile. This approach will tend initially, to improve the average level of push-up-pull-up-sit-up (p-p-s) performance in the Cadet Wing, thus the Cadet Wing scores on p-p-s should be re-normed and the absolute average level of Cadet wing p-p-s performance re-examined, prior to each admissions cycle, to set candidate p-p-s performance criteria. Using the current PFT T-score conversions (see Technical Report, Tables 1 and 2), the following combined minimum level (summed 20th percentiles) would be required of candidates.

	Men	Women
Pull-ups	5	2
Push-ups	28	7
Sit-ups	52	46
TOTAL	85	55

A woman candidate who could accomplish one pull-up and two push-ups would pass the test by performing 52 sit-ups, bringing her total score to 55. There may be limitations to this method, imposed by the maximum scores possible (99th percentile) on each test item. All methods of communication, including the Pre-Candidate Questionnaire (PCQ) Kit and the Admissions Liaison Officer (ALO) force, should be used to inform USAFA candidates of the nature and criteria of the strength test and of the need to train for it.

b. Coordination. There are a few, if any, generally acceptable measures of whole-body coordination. The participants concluded that the 300-yard shuttle run is adequate for use as an interim test, with the caveat that this test item should be studied with the intention of improving it. Dr Wilkerson will accomplish some of that work at Indiana University during investigations already in the planning stage. The recommended procedures for shuttle-run testing are those set forth for the current PAE. The criterion level for passing the test should be set at two standard deviations (sd) below the mean of the existing distribution for candidates (to be reconsidered and/or re-normed prior to each admissions cycle). The 2-sd criterion eliminates the lower 2.3 percent of individuals in a given distribution.

c. Aerobic Power. As facilities, equipment, and trained personnel become available, submaximal testing of aerobic power, using bicycle ergometers, should be implemented in the field. The submaximal bicycle test was identified by the workshop participants as being the most reliable and meaningful field deployable technique for aerobic power determination. The simplicity, reliability, and ruggedness of the Monark brand bicycle ergometer were recommended as criteria by which to judge an acceptable ergometer for eventual purchase. No reliable, interim test for aerobic power was found to be acceptable, though the original version of the Harvard Step Test (carrying individualized amounts of extra weight in a backpack) was considered, as was the 1 1/2-mile run. The former was labelled as unreliable (much greater random error variation than the bicycle test), and the latter was thought to be impractical for indoor testing. In lieu of an interim test of aerobic power, bicycle ergometry will be conducted during the 1982-83 admissions cycle at four of the current (PAE) testing sites: USAFA, supported by AHPAR (Capt Coté); Randolph AFB, supported by USAFSAM/VN (Drs Myhre and Miller); Los Angeles, supported by the UC Institute of Environmental Stress as part of ongoing AFOSR contracts (Dr Horvath working with Capt Shaddock); and Bloomington IN, supported by Indiana University (Dr Wilkerson working with the (PAE) testing officer for Bloomington). The protocol to be used in these feasibility tests will be that developed by Dr Myhre, mentioned above.

d. Body Composition. The currently accepted criterion measurement for body composition is body density determination (also known as underwater weighing). The field deployment of this method is not practical at this time (future implementation by DUDMERB during medical examinations would be admirable). One of the best predictors of density-determined body composition is an algorithm that uses height, weight, triceps skin fold, and knee diameter. Capt Coté has access to this algorithm and will make it available for use in the CPFT. Two kinds of calipers will be required for these measurements: Drs Myhre and Miller will explore purchase/construction options for them. The training of 1982-83 test site directors in the use of the calipers will be initiated by letter and followed up at RRV area meetings (this will require training the five RRV Area Officers). A calibration method for the calipers in the field is yet to be worked out. The criterion values for the allowable proportion of fat in the body should be the national college mean, as determined by underwater weighing (Dr Horvath has most of those data). In other words, candidates' percent body fat must be less than the national college mean in order to qualify for appointment. The criterion means must be specific to the applicants' sex and race. Marginal candidates could be directed by RR to high-quality underwater weighing sites.

6. The exact nature of the 1982-83 CPFT should be determined by a USAFA project officer in March-April 1982. Several guidelines were recommended. First, a constant time interval for the tests should be used, as for the PFT: in the PFT, three minutes each are allowed for pull-ups, long-jump, push-ups, sit-ups, and the start of the 600-yard run. Second, current waiver and retest policies should not be revised at this time. Finally, it was agreed that "warming-up" has little effect on physical performance. Instead of the structured PAE warm-up, a standard amount of time should be given to the candidates to "stretch" and "limber up."

In summary, the workshop participants recommended three actions. First, discard the idea of measuring candidate physical aptitude in favor of measuring candidate physical fitness. Second, pursue the highest level of competency in physical fitness testing. This should be accomplished by implementing measurements of static and dynamic muscular strength, whole-body coordination, aerobic power, and body composition that are both practical and reliable. Three, implement the recommended CPFT as the first in a several-year series of steps toward the desired level of competency.

## Work Plan

March-April 1982 - A project officer, preferably Capt Shadduck, should pull together a new CPFT Testing Officer's Handbook and design the needed mark-sense reporting forms for the 1982-83 testing dates. He should also prepare a letter for dispatch in May to Test Site Directors informing them of the advent of the CPFT. Dr Miller will prepare a one-page description of the CPFT to be sent out in the PCQ and to ALOs. Drs Myhre and Miller will identify calipers to be purchased and/or constructed and get those efforts under way. Dr Myhre will distribute his bicycle ergometer submaximal test protocol to Drs Wilkerson and Horvath and to Capt Coté. Capt Coté will give RRE (Capt Strickland) the body composition algorithm that will be used in 1982-83, and prepare instructional materials for the five RRV Area Officers concerning use of the calipers.

October-November 1982. The first CPFTs will be conducted. Bicycle ergometry will be conducted at four test sites.

November-December 1982. The workshop participants will reassemble to consider the results of bicycle ergometry and the adequacy of CPFT procedures.

February-March 1983. Additional bicycle ergometry will be conducted at the four test sites. CPFT procedures for the 1983-84 admissions cycle will be formalized by the Project Officer.

List of Participants  
USAF Physical Fitness Testing Workshop

1. James C. Miller, Ph.D. (Convener)  
Research Physiologist, Crew Performance Branch (VNE),  
USAF School of Aerospace Medicine, Brooks AFB TX 78235,  
and Admissions Liaison Officer Coordinator (USAFR), USAFA/RRV  
(512) 536-3464. AUTOVON 240-3464.
2. Steven M. Horvath, Ph.D.  
Director and Professor, Institute of Environmental Stress,  
University of California, Santa Barbara CA 93106  
(805) 961-2350 or 2361.
3. James E. Wilkerson, Ph.D.  
Associate Professor, Department of Physical Education,  
Indiana University, Bloomington IN 47405  
(812) 335-0673 or 1637.
4. Loren G. Myhre, Ph.D.  
Research Physiologist, Crew Protection Branch (VNB),  
USAF School of Aerospace Medicine, Brooks AFB TX 78235  
(512) 536-3814. AUTOVON 240-3814.
5. Capt Robert D. Shaddock  
Admissions Liaison Officer (USAFR) and PAE Test Director,  
Admissions Liaison Office (RRV), USAF Academy  
2939 Cardiff Ave., Los Angeles CA 90034  
(213) 837-9777 (H). (213) 535-5290 (W).
6. Col Warren L. Simmons  
Director of Admissions and Registrar (RR),  
USAF Academy CO 80840  
(303) 472-2640. AUTOVON 259-2640.
7. Col Richelieu N. Johnson  
Head, Physical Education Division (AHP),  
USAF Academy CO 80840  
(303) 472-2798. AUTOVON 259-2798.
8. Maj William J. Strickland  
Directorate of Institutional Research (RRE),  
USAF Academy CO 80840  
(303) 472-3225. AUTOVON 259-3225.
9. Maj P. Richard Elliott  
Associate Professor and Chief, Analysis Division  
Athletic Department (AHPA),  
USAF Academy CO 80840  
(303) 472-2282. AUTOVON 259-2282.
10. Capt Richard W. Coté  
Associate Professor and Director, Human Performance Laboratory,  
Athletics Department (AHPAR),  
USAF Academy CO 80840  
(303) 472-3428. AUTOVON 259-3429.

## APPENDIX C

### RELATED PROJECTS

#### Strength and Stamina Standards Raised\*

The Air Force has noted increasing complaints by unit commanders and supervisors that their people lack adequate strength or stamina to perform tasks called for by their jobs. A special effort is under way to establish better entry criteria for heavy work specialties. The Air Force Aerospace Medical Research Laboratory (AFAMRL), the Air Force Surgeon General, and personnel specialists are working to improve the matching of individual capabilities with physical demands.

The AFAMRL-directed effort includes on-site measurements of job requirements (tasks, tools, equipment, etc.), development of and advanced Strength Aptitude Test Battery (SATB), and new recommendations for strength and stamina criteria for each job. This large-scale research effort is expected to be completed late this year.

Meanwhile, pending a new SATB, changes are being made for known strength-problem skills. Specifically, heavy work skills (those categorized as X-1) now require an individual to demonstrate the ability to lift 100 pounds to a height of six feet, compared to a previous weight requirement of seventy pounds. The lifting of seventy pounds to a six-foot height criteria is now tagged to skills requiring moderate strength (X-2). The criteria for standard light-duty specialties (X-3) is now forty pounds to elbow height vs. the previous twenty-pound requirement. This is now the minimum strength level required for enlistment.

The specialties to which the new X-1 criteria are currently being applied cover several AFSCs (see Table C-1). Changes will be made to X-Factor standards for other AFSCs as the AFAMRL review data become available.

TABLE C-1. X-FACTOR-ONE SPECIALTIES  
(100 POUNDS TO HEIGHT OF SIX FEET)

- Survival Training
- Missile Systems Maintenance
- Electronic Warfare Systems
- Cable and Antenna Systems
- Installation/Maintenance
- Aircrew Egress Systems
- Helicopter Mechanic/Technician
- Missile Maintenance
- Electric Power Line
- Refrigeration and Cryogenics
- Heating Systems
- Pavements Maintenance
- Construction Equipment
- Fire Protection

\*Air Force Magazine, April 1982.

### Pilot Strength Screening Program\*

Gen Davis, ATC Commander, formally endorsed the AFAMRL Pilot Strength Screening Program. This occurred as a result of T-37 flight tests at Kelly AFB which showed that aft stick force requirements exceed 60 pounds for level flight and 110 pounds for a dive recovery in a run-away trim condition. A fatal accident is believed to have been caused by a combination run-away trim and the pilot having insufficient strength to control the aircraft under that condition. These facts, together with a recommendation to establish physical standards and a strength screening program for aircrew members, were presented in a staff summary sheet to Gen Davis on 15 Jul 80. Gen Davis endorsed the recommendations. The recommendation and the T-37 flight test were forwarded to Dr. Joe McDaniel (HEG) by ATC/IGFF. Another incident was reported to Lt Col Lofberg (HEG) by Maj Sietmann of HQ SAC/DOBT on 20 Jul 81. A female pilot flying a KC-135 recently scraped a wing pod on landing due to insufficient strength to operate a yoke and throttle simultaneously. It is expected that SAC will provide additional strong endorsement for our pilot strength screening program, especially since Gen Davis will be the new SAC commander. Maj Sietmann requested that we add the B-52 to the list of aircraft for which strength is a limiting factor. In making this recommendation, he was referring to male pilots, since female pilots are excluded from B-52s.

\*Monthly Activity Report, AF Aerospace Medical Research Laboratory, Wright-Patterson AFB OH, July 1981.